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SCIENCE AND NATIONALITY

SCIENCE is one of the spheres of human activity which knows nothing of boundaries and frontiers, of races and creeds. It appeals neither to tradition nor sentiment, it has no folk-lore or legends. Its study is free to all, it speaks in one language, it has but one object, but it is the handmaid of all art, all industry and all human progress. "Science, like Nature, to which it belongs," said Davy, "is neither limited by time or space. It belongs to the world and is of no country and no age." Pasteur's view was that "Science has no nationality because knowledge is the patrimony of humanity, the torch which gives light to the world". It is justifiable to write of Chinese art, Byzantine art, Moorish architecture, Italian painting, Greek sculpture and Russian literature, but science cannot be divided into such chapters. The contributions of the ancient, the medieval and modern worlds and of all continents are interwoven and inseparable. Illimitable in its extent, the edifice of science may be compared with the temple of art of which Lafcadio Hearn wrote to the musician Krehbiel. In this temple, he said, "the more you advance the more seemingly infinite becomes the vastness of the place, the more interminable its vistas of arches and the more mysterious its endless succession of aisles. . . . The Vatican with its sixty thousand rooms is but a child's toy house compared with one of the countless wings of art's infinite temples." In the erection of this great structure of science, a multitude from many lands have assisted, and their work is seen to-day in the sky and on the sea, in factory and field and around our hearths and homes, touching every side of life.

But though science knows nothing of frontiers and boundaries, its investigators have homes and belong to some particular community, and it is but natural that these communities should take a special pride in their notable men, upholding their reputation and honouring their memory. Thus it comes that memorials are set up where the great were born, where they laboured and where they died, and such memorials become the shrines around which on appropriate occasions commemorations are held.

The question of what it is that moves all mankind to commemorate its great men was asked and answered by the late Prof. Wilfred Trotter in his Hunterian Oration to the Royal College of Surgeons of England on February 15, 1932. "The *conscious* and *ostensible* motives," he said, "under whose influence we approach the commemoration of great men are first, to contemplate in humble piety and emulation a largeness of mind and character that far exceeds our own, and secondly to seek inspiration from struggles heroically engaged and perhaps triumphantly won." Elsewhere it was written: "we commemorate to instruct ourselves, to inspire others to act in a way similar to that of the men we revere, perhaps most of all to impress the fact of the debt of the living to the past". In the first of his seven essays on "Representative Men", Emerson remarked, "The knowledge that in the city

is a man who invented the railroad raises the credit of all the citizens". As with a city so with a nation, and one cannot but feel his own status raised by the knowledge that the great men of the present or the past belong to his own community, and all gain something from association with historic places connected with notable events or outstanding men. We all have our heroes, from whom we gain vigour and resolution, for as Carlyle said, they are "profitable company". If the hero is a Pasteur so much the better, for he it was who advised the students of Edinburgh "to associate the cult of great men and great things with every thought". It is given to but a few to come into intimate contact with the really great, but no student of science need lack knowledge of the lives and characters of famous men of science, for biographies and histories abound. It may be, as Prof. Trotter said, that "in all our commemorations, whether by word or plastic act, we make our own pictures and drift increasingly away from the actual man"; but pictures we must have, and our debt is great when a biographer succeeds in delineating vividly the man of whom he writes. "In the written records of the lives of men and women," said Lord Oxford, "we have all a common territory, inexhaustible in its range, permanent in its interest, from which pedantry itself cannot shut us out."

Inspiring and valuable as the biographies of men of science may be, still more important are the histories of science which, when written in an impartial spirit by men of knowledge and experience, provide those broad and unbiased views which are the birthright of every student. Men of science have come from all classes and all lands, a Siberian town giving birth to a Mendeléeff, a Serbian village to a Tesla and an Indian home to a Ramanujan. When von Zittel was asked to write his history of geology, it was suggested that he should record chiefly the progress of that science in Germany, but he was unwilling to accept any such limits. "All civilized nations," he wrote, "have shared in the development of the natural sciences, the history of any one of which is to a certain extent the history of a scientific freemasonry." His countryman, Prof. Matschoss, of whose death we regret to learn, in the preface to his excellent book "Great Engineers" took much the same view, remarking that "Technology is not confined within frontiers, and there is nothing in it that anyone can do entirely alone. The threads run from nation to nation and from generation to generation."

The records of all important scientific societies give evidence of the international character of science, and it is one of their self-imposed tasks to recognize outstanding achievements in lands beyond their own. The lists of the foreign associates of the Paris Academy of Sciences, the roll of the Copley medallists of the Royal Society, and the table of the Nobel laureates all illustrate the scientific freemasonry of von Zittel. Unfortunately, war between nations always brings in its train boasting and jealousy, gravely injuring the feeling of brotherhood, but in the end histories of science have little to say about dictators or tyrants, conquests or defeats. When the present disastrous struggle ends, it will be the privilege of men of science to attempt to allay national animosities and to resume speedily the friendly relations of happier times. It is much to be hoped that the day will soon come when it will again be possible to hold international gatherings, and to propose toasts similar to those given at the meeting of the American Institute of Electrical Engineers in 1901. On that occasion homage was paid to science in France, England, Germany, Italy and the United States by the toasts: "The land of Ampère; the country of Faraday; the successors of Ohm; the heirs of Volta and the legatees of Franklin".

Though the question of nationality cannot be said to be of capital importance, yet there is an urge to delve into the ancestry and early environment of notable men, and to attempt to trace the things which have influenced their careers. Nationality, of course, may be inherited or acquired. Usually the place of birth and ancestry conspire together to determine nationality, but sometimes place of birth has little to do with it. Cavendish was born at Nice, Black at Bordeaux, Lagrange at Turin, and Regnault at Aix la Chapelle, but everyone knows the first two were British and the other two French. All the early American men of science such as the Winthrops, Cotton Mather, Rittenhouse and Franklin were originally British subjects. Since, through the Revolution, Rittenhouse and Franklin became citizens of the United States, there has been a constant flow of men from many European countries across the Atlantic who have willingly abandoned their old nationality for a new. Graham Bell was born in Scotland, Elihu Thomson in England, Michelson and Berliner in Germany, Agassiz in Switzerland.

In most cases, there is no doubt about a man's nationality, but as has recently been seen in the discussion about Copernicus, the matter is sometimes complicated by various circumstances. On the occasion of the quatercentenary of Copernicus *The Times* wrote: "The middle of a great war between Poland and Germany is not perhaps the most suitable occasion for reviving an ancient controversy as to his nationality", and though Copernicus was born at Thorn, "the troubled history of that corner of Europe makes it difficult to speak with any certainty about his ancestry". There are many other corners of Europe with troubled histories—Alsace, Finland, Schleswig-Holstein and the various countries which made up the old Austro-Hungarian Empire. Many men have been good Austrians without a drop of Austrian blood in their veins. The great geologist Eduard Suess (1831–1914) was the son of a German merchant and was born in London. For nearly seventy years he lived in Vienna; but he retained his affection for England, which he called his 'native land'. When in 1929 a tablet was unveiled on No. 4, Duncan Terrace, Islington, London, his birthplace, Prof. J. W. Gregory said that "he made the higher study of geology international and thereby encouraged the growth of the international spirit". Another name famous in Austrian scientific circles was Littrow. Joseph Johann Littrow (1787–1840) and his son Karl

Ludwig Littrow (1811–77) were both directors of the Vienna Observatory. The elder of the two was born and educated in Bohemia, and in 1810 went to Kasan, Russia, where the younger was born. The famous naturalist Johann Gregor Mendel (1822–84) was always an Austrian subject, but his birthplace was the Silesian village of Heinzendorf, and his work on heredity was done at the old monastery at Brünn, Moravia. Ignaz von Born (1742–91), who was in the first rank of European mineralogists, and a councillor of state at Vienna, was a native of Carlsburg, Transylvania, now a part of Rumania.

That troubled corner of Europe, Alsace, now again in German occupation, belonged to France for nearly two centuries before it was annexed by Germany in 1871, only to become French again after the War of 1914–18. It has given a long line of distinguished men to France. Strasbourg was the birthplace of the chemists Wurtz, Schutzenberger, Friedel and Gerhardt. Pasteur once held a chair in its University and his statue was erected there. Other men of science have come from Colmar and Mulhouse, nearly all of them of French nationality. Another 'corner' of Europe—Holstein—was the birthplace of the astronomer, F. G. W. Struve (1793–1864). The Struve family is sometimes spoken of as German, but the astronomer was the son of a Danish schoolmaster and was born at Altona, a city which had been Danish for a century and a half. By their work at Dorpat and Pulkova, Struve and his son became subjects of the Russian Tsars and also great international figures.

Of all countries, with the exception of the United States, none has benefited more by the labours of men of science of foreign birth than Great Britain. To-day, history is only repeating itself, for our love of liberty and our free institutions have again and again made our land a sanctuary for men fleeing from religious or political persecution. When Louis XIV, by the Revocation of the Edict of Nantes in 1685, drove half a million of his most industrious subjects to seek asylum abroad, many of them came to England. To this we owe the Dollond, Demainbray and Desaguliers families, all known in the history of science—the Dollonds for their optical work, the Demainbrays for their labours as the King's astronomers at Kew, and the Desaguliers, father and son, for their respective studies in natural philosophy and gunnery. With the Dollonds also came Abraham Demoivre, the mathematician and close friend of Newton. The accession of George I naturally led to closer relations between England and the Continent, and from Germany to Great Britain came Dillenius, the professor of botany at Oxford, John Müller, the first headmaster of the Royal Military Academy, Woolwich, and the most famous of all British astronomers, William Herschel. From Sweden came Solander, keeper of natural history in the British Museum; from Italy, Cavallo, the electrician; from Holland, Ingenhousz, physician and physicist; and from Switzerland, Dr. Marcet, whose wife, Mrs. Marcet, a Swiss woman wrote the book on chemistry which stimulated Faraday. Another native of Geneva resident in England was Deluc, the geologist and meteorologist, and it may be recalled that W. T. Brande, the colleague of Faraday at the Royal Institution, was the son of a Hanoverian medical man. There are many other names inscribed in the history of science in Britain, like those of Rücker, Meldola, Sabine, Kater, Negretti and Siemens, which remind us of our debt to other nations.

Another chapter in the relations of Great Britain with Germany opened with the marriage of Queen Victoria and Prince Albert. It was largely due to the Prince and Sir James Clark, the Court physician, that the Royal College of Chemistry was opened in 1845 with Hofmann at its head. Three years previously, Liebig, accompanied by Dean Buckland and Lyon Playfair, had made a sort of triumphal tour through England. Playfair had studied under Liebig at Giessen and from that time onwards British students of science flocked to Giessen, to Göttingen, to Heidelberg and so on, to sit at the feet of Wöhler, Bunsen, Kirchhoff and other famous teachers. Tyndall, Frankland, Muspratt, Gilbert, Williamson, Gladstone, Sylvanus Thompson, Perkin, Smithells, Roscoe and Ramsay are a few of the distinguished men who worked in German laboratories. From Germany, too, came Voelcker, Dupré, Sprengel, Hugo Müller, Ludwig Mond, Messel, Dittmar, Schorlemmer and many besides to teach or engage in industry in Great Britain. The remarkable comradeship which existed between Continental and British chemists in the time of Victoria is fully shown in the series of memorial lectures delivered to the Chemical Society.

Though there is no question that Great Britain, and the British Empire also, have benefited greatly by the labours of men of foreign nationality, the debt has been by no means one-sided. As British chemistry students went to Germany, so foreign students came to England to learn engineering and shipbuilding. Mechanical engineering in Sweden, Russia, Italy and Switzerland owes much to such as Owen, Baird, Guppy and Charles Brown. It was William Wilkinson who erected the first blast furnaces at Le Creusot, and from the original works of Philip Taylor sprang the Forges et Chantiers de la Méditerranée near Toulon. One of the makers of modern Hamburg was the civil engineer William Lindley, whose son Sir W. H. Lindley designed public works for Frankfort, Budapest, Baku and other places. At one time there was a British engineer in every port in the world from Tokyo to Buenos Aires.

All these facts go to show that there can be no such thing as isolation in scientific matters. In March 1942 Sir Henry Dale, in a letter to *The Times* about the tercentenary of Newton, said that his achievement in science is the heritage of all men. This applies equally to every scientific inquirer, from the most brilliant genius to the humblest of those who endeavour to increase natural knowledge; and in honouring such men as Kepler, Galileo, Harvey, Swammerdam, Berzelius, Newcomb, Fresnel, or Pavlov, we pay homage to the great band of seekers after truth wherever they were born or whatever their nationality.

PROLEGOMENA TO PLANNING

Creative Demobilisation

(International Library of Sociology and Social Reconstruction.) Vol. 1: Principles of National Planning. By E. A. Gutkind. Pp. xvi+331. 21*s.* net. Vol. 2: Case Studies in National Planning. Edited by E. A. Gutkind. Pp. viii+280. 21*s.* net. (London: Kegan Paul and Co., Ltd., 1943.)

ALLIED successes in the autumn of 1942 were immediately reflected in Great Britain in the new focus of attention towards post-war programmes and policies. The warm welcome of the Beveridge Report was in large measure attributable to its timely appearance. Since then dozens of plans for agriculture, for particular industries, for special areas and for bombed cities have appeared. Yet it is remarkable that there have appeared only two works which discuss comprehensively the objectives and principles of planning. Prof. Hutt diagnoses pre-war trends and practices in his "Plan for Reconstruction" and outlines a consistent post-war economic policy for Britain which, he believes, removes the major defects that have hitherto marred a smooth working of economic forces. The second work is that by Dr. Gutkind, who establishes the general principles of town and country planning, and applies them to Britain. It would be instructive to examine the common features of these two essays, both of which are published in the International Library of Sociology and Social Reconstruction. Here, however, we can simply note the sense of urgency with which both authors write. Dr. Gutkind believes that "failure to identify the demobilisation with a creative beginning of a new era will be tantamount to a new declaration of war". The unpreparedness for peace shocks him, yet he will have none of hand-to-mouth policies. From the armistice we must concentrate our whole might on the "goal of making Britain one good house"; and this attitude helps to explain the author's impatience with possible criticisms of his approach, and his contempt for *laisser faire*.

The first volume, of which Dr. Gutkind is author (of the second he is editor), states that the foremost objective of town and country planning is the creation of an inspiring and diversified environment. With this few reasonable men will quarrel, but that general agreement is likely to evaporate when the general principles the author formulates come to be applied. The chief of these principles is the decentralization and dispersal of settlement. We are told "Decentralisation should be understood not in the narrower sense of decentralisation of industry but in its broader meaning of decentralisation of settlement—the loosening up of too densely populated urban districts by the development of new, or by the further development of existing, places within the direct sphere of influence of the urban centre which is to be re-developed. Dispersal, on the other hand, can be defined as the same process but spreading beyond the confines of the area from which the overflow is to be drained" (p. 219). The fundamental aim of pursuing a national plan which embodies these principles is the fashioning of the environment of man according to his social needs as a free individual. This involves the establishment of a sound balance between the four functions—housing, working, distributing and recreating—which constitute our being. This functional division is analogous to the division, made by the classical economists, of the productive process into production, exchange, distribution and consumption, and the use of this analogy might have facilitated the exposition of the idea of a 'balance'. The notion of a balance of these functions is Dr. Gutkind's yardstick, which is applied in successive chapters to British agriculture and industry.

In Great Britain to-day more muddled thinking is devoted to the ills and future of agriculture than to any other topic, with the possible exception of finance. What happens when Dr. Gutkind applies his principles? They lead him to identify himself wholeheartedly with the school of thought which has found its most recent expression in the majority report of the Scott Committee on Land Utilisation in Rural Areas. "Agriculture", says the writer (p. 123), "must be accepted as a basic industry, and its fundamental function in the national economy must govern its development—neither charity nor antiquarian aesthetics are a sufficient basis for an agrarian policy." But what is the sufficient basis?

Although the nineteenth century belief in cheap food might have gone too far and suffered from a measure of shortsightedness, it was not without some solid justification both from the national and international points of view. Freedom from want cannot be comfortably maintained if every national area adopts autarchic agrarian policies on social grounds. The legacy of fear and distrust left by the War of 1914–18 and the Great Depression will not be thrown off, much less the fuller life be attained, by such policies. The limits of Britain's ability in this direction without multiplying costs many-fold have been revealed in two major wars. Similarly, in respect of industry Dr. Gutkind's criticisms of past trends are somewhat immoderate. In spite of the tendency of socialist thought in Britain and industrial methods in the U.S.S.R., Dr. Gutkind maintains (p. 209) that "A further argument in favour of decentralised and scientifically run industrial units is the reduction of competitive conditions; that is important as it tends to eliminate the race for 'a place in the sun', that is, it reduces the agglomeration of industry within one region which might, as it actually has done, offer some alleged advantages over competitors who remain outside this particular region". Would he countenance pseudo-competition?

With the aid of diagrams a plan for the physical transformation of town and country is unfolded. Here the author's views agree with those of Lewis Mumford. Three stages of action are suggested in order to accomplish the functional plan: first, the splitting up of the whole congested area into sections by a system of linear arteries, thus producing the primary grid of green belts and roads which permits of recreating and distributing; secondly, the differentiation of these sections among the main categories of use by a system of spatial zoning which creates an organism of residential and non-residential districts for housing and working; and, thirdly, the further subdivision of these units by a system of 'functional spotting' which leads to a secondary grid of open spaces and streets. In this way a functional balance is gained. The scheme is ably evolved.

In the second volume the twenty-two separate memoranda are grouped similarly to the main chapters of Vol. 1. Profs. A. W. Ashby, J. H. Jones and A. G. Ogilvie, and Messrs. E. G. Bowen and J. R. Currie are among the contributors. All future workers in this field will be grateful to Dr. Gutkind for bringing together such an array of facts and views as we find

here; and there is a need for further work. Dr. Gutkind has not said the last word on the principles of national planning. He has made a useful, provocative beginning, and not sought finality.

D. J. MORGAN.

HOMES AND INCOME

(1) An Enquiry into People's Homes

A Report prepared by Mass-Observation for the Advertising Service Guild. ("Change" Wartime Surveys, No. 4.) Pp. xxiv+228. (London: John Murray, 1943.) 10s.

(2) War-time Pattern of Saving and Spending

By Charles Madge. (National Institute of Economic and Social Research, Occasional Papers, 4.) Pp. viii+140. (Cambridge: At the University Press, 1943.) 6s. net.

(1) ALL but the least observant would agree that the war motive that governs the actions of the people of Great Britain is not only to defeat the common enemy but also to create by exertion and example a nobler Britain and a happier world. This report has been prepared by Mass Observation for the Advertising Service Guild as a contribution to the responsible task of rebuilding a better Britain; with its publication these two bodies have earned the gratitude of every man of goodwill.

The merit of this inquiry into housing conditions and services is that it was undertaken at the level with which post-war planners will have to deal if they are to see their schemes go beyond the paper stage—the level of the people. To-day we are assailed by the conviction that this is to be the age of the common man. It is fitting, therefore, that inquiry should be made into the way the common man lives and the way he would like to live. If he can see that reconstruction involves accomplishment of some of his dreams and desires, the more likely is the British citizen to continue his labours unabated during the immediate post-war period, with all its reaction from stress and strain, and build up a better ordered society.

The survey was chiefly concerned with attitudes to housing among the working classes and was carried out in eleven different places in England, starting in August 1941 and finishing in April 1942. These places were chosen to cover representative types of housing: old houses, L.C.C. estates, garden cities and flats—and, where possible, districts were selected where another social survey had been conducted by Mass Observation before the War, so that comparative pre-war data should be available. In 90 per cent of the cases the people interviewed were housewives; whether this was expedient or from choice the report does not make clear. Important age and sex differences between those interviewed are carefully analysed, while the entire sample was almost evenly divided between the two working-class grades, skilled workers or artisans, and unskilled workers. The results of the survey are comprehensively recorded and will amply repay close study by architects, sociologists, politicians, town-planners, civil servants, etc.

Almost all the features that go to the making of a happy home have been considered and are too numerous to be considered separately here. The following are among the more important of the general observations that arose as a result of the inquiry. The needs and wants of the people are so varied that it will be impossible to satisfy everyone. On the whole, people are attached to their present homes and, although they grumble, would be prepared to make the best of a bad job if the glaring faults of their houses were put right. In many cases, the addition of a bathroom or a hot-water system would be enough to make the householder contented with her lot, while an extra cupboard in the kitchen or a modern labour-saving range instead of the old-fashioned coal ranges would be enough to satisfy other people.

The houses-versus-flats controversy is given the blow which should knock it out as the favourite artificially introduced subject for discussion groups. The mass of the people still prefer to live in a small house or bungalow with a garden: the garden city or housing estate has particular appeal. "Yet good and well-built flats, near people's work place, are suitable for some, and are appreciated particularly if they incorporate amenities such as constant hot water, lifts and playgrounds for children. At present, the choice is usually between a house and a garden a long way away from the work place and a flat reasonably near work. If people could, without having long journeys to work, live in a house of their own, the majority would infinitely prefer it."

Another point that needs scrutiny is that the younger people tend to be much more discontented with their lot than older people, while nutritionists will not be surprised to read that people are very reluctant to alter their feeding habits even in the face of acute food shortage.

The most disquieting feature of the report is an observation which is revealed indirectly rather than as answers to leading questions. In attempting to find out how much people liked the neighbourhood in which they live, the interviewers were astonished to find that "less than one person in a hundred mentioned any activity that involved co-operation with their fellow-citizens. The idea of living in a neighbourhood thus appears to have virtually no connection with any responsibility for its good government in the mind of the average housewife. There was no single reference to political activities, practically none to any local authority except in so far as it was a landlord and only a few to various forms of social, cultural and religious activity." If we accept the idea that the basis of democracy lies in the mutual responsibility of a community and all the individuals composing it, it would appear that we have a long road to travel before the idea is put into practice in Great Britain.

(2) Mr. Madge's book deals with an inquiry made into the way that spending and saving have changed during the War. The methods used were similar to those adopted by Mass Observation, but differed from them in the use of a much smaller team of interviewers. Surveys were carried out in the cities of Bristol, Glasgow and Leeds, additional material being provided by the actuary of the Aberdeen Savings Bank.

The investigation began as an attempt to find out how much of their income was being saved by wage-earner families by asking a random sample of them a number of direct questions about their savings. Because of tendencies to conceal some forms of saving from the questioner, the results proved unsatisfactory.

The inquiry was then extended to obtain particulars of spending as well as saving. It was thus possible to see whether the account given balanced with what was known of the family income.

The interviewing was carried out in an extremely thorough manner, and eventually reached a high point of efficiency. Of special interest in the general conclusions is one observation which keeps obtruding itself. While saving was shown to vary greatly among individuals, it became clear that a large proportion of wage-earners' savings are due to a small proportion of wage-earners. It is evident that, after the War, this must mean that the small proportion of wage-earners with a strong propensity to save will emerge as a special group with special interests, considerably richer than their fellows. This group, which has been steadily increasing during the past fifty years, is likely to develop even greater political significance in the future.

Another interesting conclusion which is presented in the report is that the average husband keeps roughly a quarter of his earnings as pocket money. The retention of such a large share of his earnings may be due to the husband's desire to indulge his own psychological inclinations towards the act of spending.

The report is rounded off by two appendixes, which have been prepared by Erwin Rothbarth. One contains a note on a method of determining income for families of different composition and the second an estimate of national savings per family and the relation of saving to income and excess income. They add to the value of a report which would still be of great value without them. Mr. Madge and his team are to be congratulated on an admirably executed investigation in the difficult field of social economics.

T. H. HAWKINS.

MICROBIOLOGY OF THE AIR

Aerobiology

Edited by Forest Ray Moulton. (Publication of the American Association for the Advancement of Science, No. 17.) Pp. x+289. (Washington, D.C.: American Association for the Advancement of Science, 1942.) n.p.

ALTHOUGH it is fully sixty years since the classic work of Tyndall and of Miquel on air-borne micro-organisms and twenty-five years since Molisch coined the word 'aeroplankton', this is the first book in any language which attempts to deal with the microbiology of the air in any comprehensive way; and this in spite of the intensive interest in every aspect of atmospheric study which the development of aviation has created.

It is the outcome of a symposium at a meeting of the American Association for the Advancement of Science, held in September 1941, organized by the Section of Medical Sciences of the Association, and it clearly bears the imprint of its medical origin. Among the fifty-five contributors no fewer than thirty-eight are either medical men or else represent medical institutions, and twenty-eight out of the thirty-seven papers included deal with either air-borne infection or with aerial allergens. This seems to mark a significant swing back towards the view of the early antiseptic surgeons and the Flugge school, to whom air-borne infection seemed all-important, but it is a return well guarded by a stricter ascertainment of facts and by their more precise application.

No one can overlook the importance of the medical aspects of aerobiology. Sir Leonard Hill has said that man has learned by painful experience to safeguard the purity of his food and of his drink, but has still to learn to take the same precautions for the air he breathes. Yet it must be admitted that the strong medical bias of the book detracts somewhat from its general scientific consequence. There are so many purely scientific problems left aside in favour of special medical topics. For example, the methods of killing air organisms loom so largely in the contents that one is tempted to make the rude suggestion that "Aeronecrology" might have been a better title.

If this is, therefore, not quite the book for which the scattered workers in this field have hoped, if it falls a little short of epoch-making, it is nevertheless a very considerable work. Its importance lies in its value as a summary and review as well as in the new information presented. Naturally, recent American work is most fully covered, but earlier European work is somewhat imperfectly recognized and not always correctly. It is not true to say, for example, that high-altitude collections were first made by aeroplane. Christiani, Flemming and Martin Hahn all made extensive collections from free balloons before the day of the aeroplane.

We have still a very imperfect idea of the aerial flora. There has been a vast deal of ingenuity expended on devices for the capture of aerial organisms, but there is as yet no wholly satisfactory, quantitative instrument for that purpose. Electrostatic precipitation may be 100 per cent physically efficient, but it is very difficult to apply in the field and it seems to kill the organisms precipitated. No washing or filtration method is anything like perfect, and even the impingement or the centrifugal methods, which are probably the best at our disposal, are each deficient in some particular. This may explain why so much reliance is still placed upon primitive deposition methods with agar plates, but it does not excuse us for trying to found quantitative conclusions upon such demonstrably faulty practice.

The results of air collections have hitherto been too often stultified by another factor, namely, very limited conditions of culture. Beef or malt agar at 37° C. or 25° C. represent almost the whole range of conditions employed, and there is a total lack of statistically controlled analysis of variance with medium, time and temperature, such as the soil bacteriologists have used. This is a general criticism but it is not without a present application.

It need scarcely be said, therefore, that our knowledge of specific distribution, association and bionomics is well-nigh nothing. With few exceptions the ecological outlook on air problems is missing both in the present work and elsewhere. The aeroplankton as a whole is treated as temporary, like the pollen grains and the fungal spores, and the air is viewed simply as an agent of transport, even for the bacteria and yeasts. "Dust to dust" seems to be the only cycle envisaged. Yet the experiments of Trillat and others show at least the possibility that the air may be a vegetative habitat, and the large proportion of non-spore-formers present, which anyone may easily verify, needs more than a conventional explanation, unless we are to go back to the idea of 'germs', in the original Tyndallian sense.

The material in the book is treated under two main headings: "Extramural" and "Intramural".

Under the first heading, Stakman gives a survey of air-transport problems. Wodehouse provides some fine and useful plates of pollen forms and Durham treats of mould spores as allergens. Proctor and Parker give a summary of the work, mainly by the former, on high altitude collecting. ZoBell gives some interesting new information on bacteria in marine air, emphasizing the overlooked condition of halophily prevalent among them and incidentally putting an end to the myth of the sterility of oceanic air masses, on which the belief in the terriginous origin of all aeroplankton largely rests.

Keitt and Christensen give good reviews of local and distant transportation of plant pathogens. Lastly, Glick's account of the admirable aeroplane studies of insect distribution, under the care of the U.S. Department of Agriculture, whet the appetite for more facts about this infant science, which may become of such immense significance in the aerial age before us.

Under the heading of "Intramural", Wells and Wells introduce the papers included as laying the foundation of a general theory of air-borne infection. The series is comprehensively planned. It covers first the physics of microscopic particles in air suspension (Hatch, Jennison and Phelps). Secondly, there are fifteen papers on air disinfection, treating particularly of ultra-violet radiation in many aspects. Thirdly, there are six papers on the environmental control of air infection both for adults and infants and four papers of observations on the actual passage of air-borne infectants. Finally, there are two papers on the use of aerosol mists as disinfectants. The relative simplicity and effectiveness of this method, especially with propylene glycol, entitles it to greater prominence.

Incidentally, British readers will be interested in the revelation that very large stocks of cellulose acetate masks have been prepared in Great Britain for issue as safeguards in the event of serious shelter epidemics appearing. Happily they have not been needed.

Notwithstanding the regrets which have been expressed that a more all-round treatment of the subject has not been possible, the reviewer would pay high tribute to the workers concerned in producing this attractive and important book. Such an amount of modern work has here been brought together and reviewed by first-hand authorities that it is quite indispensable to all who are interested in the microbiology of the atmosphere. We may well end by submerging criticism in admiration.

R. C. McLEAN.

AMERICAN TIMBERS

Commercial Timbers of the United States

Their Structure, Identification, Properties and Uses. Published formerly under the title "Identification of the Commercial Timbers of the United States". By Prof. H. P. Brown and Prof. A. J. Panshin. (American Forestry Series.) Pp. xxi+554. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 35*s*.

A MORE suitable title for this book than that selected by the authors would have been "A Treatise on Wood Growth and Structure". The reader will find that out of 554 pages only 154 can be said to be informative on the subject of commercial timbers of the United States: these 154 pages include seventy-five kinds of woods, on which the information is limited and generally highly technical. The uses of the timbers named are drawn only from information within the United States, and a glance at the bibliography displays perhaps a somewhat insufficient research.

A treatise on the commercial timbers of the United States should not neglect the commercial aspect. The highly organized methods employed by American commercial men have played an important part in the export trade to every part of the world. The total import into the United Kingdom alone for the year 1938 amounted to no less than £3,672,747, and of oak alone to 5,841,395 feet cube, valued at £1,038,839—by no means a negligible matter.

American timbers will be met with all over the globe. The traveller in India and Burma may find himself in a railway carriage lined with American timber, and even in the most remote districts of Burma housewives may be seen using domestic articles made from American woods. None of these interests, however, is mentioned in the work before us. From a commercial point of view, therefore, the reader is left unsatisfied.

There seems to be a certain lack of clarity as to the aim of the book. In the introduction Mr. Walter Mulford says: "The American Forestry Series is intended for the college student, the practising forester, and men in the forest industries", and in a somewhat confusing manner he informs the public that "Forestry is a profession", modified later by a further statement that it "is not an exact profession", and again that "Forestry is not a science", summing up that "The American Forestry Series is to be professional in character, with as much sound science as it is possible to include". The distinction between a "profession" and an "exact profession" is difficult to understand, as also what is meant by "sound science". The claim that "Forestry is not a science" might be open to dispute. Nature has provided a wealth of forests for the enjoyment and use of mankind, and for the necessary health and safeguard of climate and soil, but this is so far as the natural forest carries us. It is clear that the science of controlling and perfecting the man-made forest has become a necessity as a result of the demands of civilization; but while the problem is interesting, the subject is beyond the scope of the present work.

Attention having been directed to certain matters in which the book fails to supply information that might well be expected, it is pleasant to be able to commend many merits which it does undoubtedly possess.

When we come to the subject of wood growth and structure, quality and texture, the origin of wood, its gross features, its woody plant cells, minute structure, and miscellaneous information, the authors are at home, and have contributed an excellent treatise for the instruction of the forest student and the ordinary reader. Two hundred and ninety pages are devoted to these subjects, presented in clear and concise terms, and fully illustrated by two hundred and twenty photomicrographs and forty-eight plates, which include representations of the timbers as they are severally constructed and as they appear when adapted to domestic use.

ALEXANDER L. HOWARD.

Elementary Structural Analysis and Design

Steel, Timber and Reinforced Concrete. By Dr. Linton E. Grinter. Pp. xiii+383. (New York: The Macmillan Company, 1942.) 18s. net.

THEORY of structures is, by general consent, a necessary subject in the curriculum of the engineering student; there is, however, considerable divergence of opinion as to the extent to which it should be supplemented by the study of design. The reason is clear: successful design calls for far more than the student can acquire within the university. There is, however, real value in giving him some training in the technique of design, and Dr. Grinter is to be congratulated on the admirable way he has presented this difficult subject.

Only the simplest basic theory is used; for example, redundant structures are reduced to statically soluble cases by suitable simplifications, and the actual numerical calculations are, therefore, easy. One of the most attractive features is the series of design sheets which so fully illustrate the book and which teach the student, by example, the importance of a logical and neat lay-out of calculations. The contents include excellent chapters on welded construction and on construction in timber, in addition to the more usual subjects.

The author naturally deals with American practice, and in a few instances the British student will observe differences; for example, a reversal of the conventional signs for bending moments and shearing forces and the fact that the Perry-Robertson strut formula, so widely used in Britain, is replaced by the secant formula. These and differences in detail design, however, add to the interest.

The book is clearly and attractively written and can be thoroughly recommended to any student as complementary to his study of theoretical structures. He is difficult to please if he does not read it with enjoyment as well as benefit.

A. J. S. PIPPARD.

An Introduction to the Modern Theory of Valency

By Dr. J. C. Speakman. Second edition. Pp. 159. (London: Edward Arnold and Co., 1943.) 5s. 6d. net.

IN this book the author conducts his readers carefully and pleasantly through the complex maze of valency problems. Particularly valuable, in the reviewer's opinion, is the discussion of polar and non-polar compounds in Chapter 9 in terms of characteristic properties like dielectric constants, association and so forth. A very fair and reasonable balance is held between the views of the leading authorities, and thus the student is encouraged to use his analytic and critical faculties as his own knowledge progresses.

So far so good. But the fact has to be faced sooner or later (and that it is not faced here and now is by no means Dr. Speakman's fault) that a real comprehension of the *modern theory* of valency demands mathematical ability and equipment of an order probably altogether different from that envisaged in the average physico-chemical laboratory. It is thus just worth pondering whether 'descriptive' books on the subject are wholly justified these days. If they are, the present one is an excellent example of what can be done. On the other hand, there seems a certain awareness in these pages that all is not plain sailing: maybe a mathematical appendix to help bridge the gap and point out the heights beyond might remove some heart-searchings on this score.

F. IAN G. RAWLINS.

School Physics

By T. M. Yarwood. Part 1. Pp. xii+366. (London: Macmillan and Co., Ltd., 1943.) 5s.

THIS book contains the work for the first two years of a four-year concentric course in physics up to School Certificate standard. The remaining two years' work is to be dealt with in a second volume.

Although there are many books already available which fulfil the same purpose, this one will have a good reception. There is nothing new in the presentation of the principles; its difference lies in the many descriptions of modern appliances and the references to the applications of physics in everyday life. Many of these are too complicated for the younger boy but, as the author points out, much can be omitted from the first reading and left until the School Certificate year, when both Parts I and II should be used.

The book is attractive. It is well set out and has an abundance of good diagrams. The modern applications will appeal to the boy and, what is of paramount importance, attract him to read the book out-of-school. There are many references to aeronautics, and war-time publication is marked by the inclusion of descriptions of modern creations such as the barrage balloon.

The style is good, but a boy of eleven may find the language a little too difficult. The examples, which are collected at the back, are not very numerous but nevertheless sufficient. It is disappointing that the few extra topics required for the physics section of the General Science syllabus are not included, for, with such additions, the book would have the much wider appeal it justly deserves.

On Pseudohypertrophic and Allied Types of Progressive Muscular Dystrophy

By Julia Bell. (Being Part 4 of Vol. 4, "Nervous Diseases and Muscular Dystrophies", of "The Treasury of Human Inheritance".) Pp. iv+283-342+plates 33–44. (Cambridge: At the University Press, 1943.) 12s. 6d. net.

DR. JULIA BELL has contributed a useful monograph on muscular dystrophy in man to "The Treasury of Human Inheritance" series. Clinical and genetical data from more than 1,300 individuals exhibiting this distressing abnormality are analysed in regard to mode of inheritance, prognosis, symptoms, fertility and time of onset. She divides the clinical types into three groups but points out that intergrading may occur. Each group on the whole persists in one family and is partly related to one of three genes which behave as dominant, recessive or sex-linked respectively. Several problems relating to development and transmission of the abnormality are discussed.

Dr. Bell points out that if 140 individuals had abstained from parenthood, there would have been a reduction of 468 dystrophic and 1,195 apparently normal individuals. Of these the members of the dominant gene group live long and may produce a proportionately large number of dystrophic and normal non-carrier individuals, while the affected members of the sex-linked group have a short life and will not affect the future generations to any great extent. The publication of such analytical résumés as this by Dr. Bell is of great value to science and medicine.

F. W. SANSOME.

PHOTOGRAPHIC ANALYSIS OF MOTION*

By E. R. DAVIES

Kodak Research Laboratories

TO-DAY we turn naturally to photography to analyse movements which are too rapid for our eyes to follow. If we tend to take this powerful weapon too much for granted, it must be remembered that there were formidable experimental difficulties facing the investigator before the advent of photography. Marey, while director of the Physiological Station in Paris, devised a most ingenious way of studying the movements of a horse. Pressure chambers fitted to the underside of the horse's hooves were connected by pneumatic tubes to a recording mechanism held by the rider, which registered the time of duration of contact of each hoof with the ground. Marey did much painstaking work along these lines between 1860 and 1880.

Muybridge, a native of Kingston-on-Thames, was conducting a photographic survey of the Californian coast in 1872 when he was appealed to by Governor Sandford to settle a controversy which was raging in San Francisco and which was aroused by Marey's analysis of the movements of a horse. The question was whether a trotting horse ever had all its feet free of the ground simultaneously. Muybridge set himself the task of obtaining photographic proof and achieved immediate success. He used a camera fitted with what may be loosely described as an instantaneous shutter and, taking photographs at random, soon obtained one which showed all the horse's feet free from the ground. The controversy was settled; but, more important, the direction of Muybridge's life's work was settled also.

For the exhaustive investigation of animal locomotion, upon which he soon embarked, Muybridge erected an elaborate apparatus on the racecourse at Palo Alto, near San Francisco. A battery of twenty-four cameras was arranged along one side of the track. Across the track was stretched a number of threads each connected to the shutter on one of the twenty-four cameras. The camera shutter was in the form of a guillotine urged downwards by a spring, and was released by an electro-magnetic relay on the breaking of the thread. In this way, as the horse passed in front of the cameras, it broke the threads in succession, and a series of instantaneous photographs was obtained. The time of exposure given by the shutters was of the order of 1/1,000 sec., and it is remarkable that Muybridge was able to obtain sufficient exposure with the photographic materials available to him. This was the time of the wet-plate process, and, compared with modern practice, photography was laborious in the extreme. To obtain sufficient exposure, Muybridge arranged a sloping white background to catch the light of the sun. Against this the horse stood out in sharp relief. Even so, his early results were mere silhouettes lacking all detail. With the increasing use of the gelatin dry plate (invented by Maddox in 1871), the photographic process was greatly simplified, and the sensitivity to light was increased many times. In his later work, Muybridge was thus enabled to obtain photographs showing detail. An impression of the scale of his operations will be gained from the statement that he exposed no fewer than 100,000 plates in the two years, 1884 and 1885.

Muybridge showed how the pictures taken successively by his battery of cameras could be combined to reproduce the appearance of the original movements. He printed his negatives in order on a band of paper. One of his original records was presented to the Royal Institution following the discourse he gave in 1882. The record, which is still preserved at the Institution, is placed in an apparatus known as a zoetrope, which is simply an empty cylinder with vertical slots arranged at equal intervals around the circumference, and it is carried on a vertical axis. On rotating the cylinder the pictures are viewed in succession through the slots and appear to be in motion. Muybridge thus raised a toy of the Victorian drawing-room to the status of a scientific instrument, and used it to demonstrate the correctness of his method of photographic analysis. The zoetrope, and other improved designs for which he was responsible, may be rightly regarded as forerunners of the modern cinematograph projector.

The cinematograph projector and camera were brought a stage closer by Marey, who, in his chronograph, employed a band of film on which successive photographs were taken, and who devised another apparatus for viewing the results by projection on a screen. Marey was a most remarkable man. I have already mentioned his work with pressure chambers and pneumatic tubes. Introduced to the photographic method by Muybridge, he was quick to seize upon its possibilities. His book "Le Mouvement" (published in 1894) reveals him as a brilliant experimentalist. His investigations covered the analysis of the locomotion of many animals, of birds in flight, of insects and even of micro-organisms by means of photography under the microscope. Few developments in high-speed photography were not visualized, and in some part realized, by him.

As typical of his work, I will single out for mention one technique which has proved of lasting value. Marey built a camera in which the shutter was a disk with radial slots. This revolved in front of the camera lens and caused a series of photographs to be taken in rapid succession on the same plate. In place of Muybridge's brilliantly lit background against which the moving object was revealed as a silhouette, Marey used a black background and whitened his object. In this way only the object (and not the background) was recorded during the successive exposures of the plate.

Marey's rotating disk shutter with its radial slots gave individual exposures of about 1/25,000 sec. This was an advance on Muybridge's shutter time of 1/1,000 sec., but is nevertheless far too long a time for many purposes. Mechanical shutters of any type have obvious limitations due to the inertia of the moving parts. But the problem can be approached from a different angle. It will be obvious that the desired result will be obtained if the camera shutter is left open and the subject illuminated instantaneously. Light flashes can be obtained of extremely short duration, and their use in 'stopping' rapid motion represents a milestone in the road of progress.

Lord Rayleigh used magnesium powder for a slow flash, and the electric spark for a fast flash with a time of duration of the order of one millionth of a second. With this he was successful in photographing a soap film in the act of disrupting—a phenomenon that takes place with extreme rapidity.

* Substance of a Friday discourse delivered at the Royal Institution on December 11, 1942.

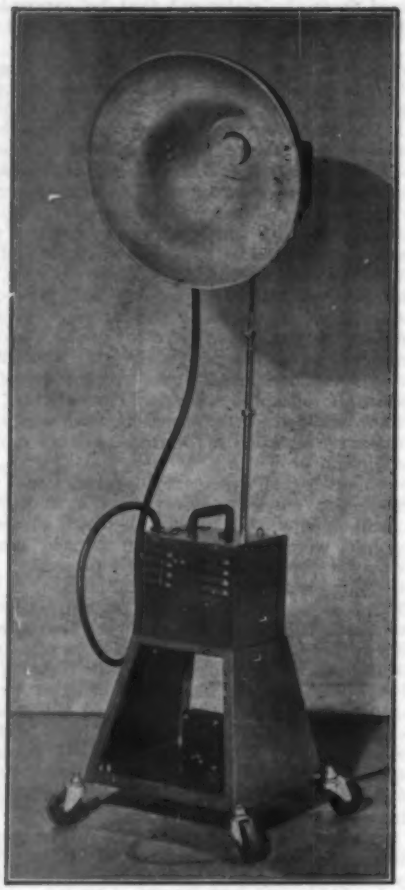

FIG. 1. KODATRON SPEED LAMP.

Prior to this time Worthington had used the electric spark in his beautiful experiments on the formation of drops and the mechanism of splashes*. His early work was not photographic. He observed different phases of the splash made apparently stationary by the light of the flash, and sketched what he saw. For his later investigations on surface tension phenomena he used photography.

The electric spark is fast enough to permit the photography of projectiles in flight. Sir Charles Boys took such photographs around 1890. They were shadow photographs; no camera or lens was used. The bullet passed between the photographic plate and the spark, and thus cast the shadow. In front of the plate, and in the line of flight, were two wires forming a gap in series with the spark gap. As the bullet bridged the gap, the fall in the resistance of the circuit caused the spark to pass and the photograph was obtained. Many associated phenomena are clearly revealed in such photographs. The nose of the bullet forms a bow wave. This travels with the speed of sound in air, about 1,100 ft./sec., and Boys showed how the speed of the bullet can be calculated from the angle between the bow wave and the line of flight. The bullet, though travelling at more than twice the speed of sound, is revealed with extreme sharpness by the spark, which lasts for less than one millionth of a second. Boys succeeded in measuring the duration of his spark by reflecting it on to a photographic plate by a rapidly revolving mirror and measuring the length of the trace—a method which we still use to-day.

Boys' projectile photographs bear comparison with the most modern work. The chief difference seen in the beautiful photographs published by Quayle of the Bureau of Standards in 1925 is the absence of the synchronizing wires. Quayle fired his spark by means of a microphone actuated by the noise of the explosion. This method was suggested by Dr. Mach of Vienna, whose father, Prof. Mach of Prague, was the first to obtain photographs of bullets in 1881. Mach, however, was not able to realize this method of synchronization with the apparatus available to him.

So much for the early history of the subject. By the turn of the century the principles of photographic analysis of motion were well understood: the possibilities of the method were fully realized. Advance since that time is largely a story of improvements in technique: improvements in photographic materials, in light sources and, above all, in the development of the cinematograph.

As to photographic materials, it is a story of steady improvement in quality and advance in sensitivity. I thought we had nearly reached finality a few years ago; but the War has brought forth a tremendous effort, and the fastest materials to-day are several times as sensitive as they were only two or three years ago. At a guess—it is little more in the absence of precise data—I should say that since Muybridge's time we have seen an increase of at least a hundred times in the speed of photographic materials. That is to say, we can achieve similar results to-day with 1/100th of the light.

Lenses, too, have improved out of all knowledge. But here again it is difficult to give a precise figure for the effective increase in speed, for the very fast Petzval portrait lens was introduced in 1840—within a year of the invention of photography. However, it was poorly corrected, and a common aperture in those days was $f/8$. To-day $f/1{\cdot}5$ is equally common—an increase in light-gathering power of thirty times.

To turn to light sources: the spark is an admirable way of obtaining extremely short exposures, and is probably unsurpassed when exposures of less than a millionth of a second are required. Apart from projectile photography, however, such extremely short exposures are rarely needed. A large output of light is more often desirable, and the possibilities of the spark in this direction are severely limited.

Recent developments of the gas discharge tube have resulted in a much more generally useful source of light. For the cold

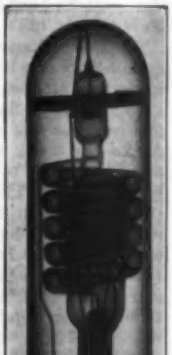

FIG. 2. RADIOGRAPH OF THE GASEOUS DISCHARGE TUBE AND MODELLING LIGHT ASSEMBLY FROM THE KODATRON SPEED LAMP. THE DISCHARGE TUBE IS WOUND ROUND THE TUNGSTEN FILAMENT LAMP WHICH IS USED FOR ARRANGING THE LIGHTING ON THE SUBJECT. NOTE (AT THE LEFT) THE TRIGGERING ELECTRODE PASSED ROUND THE COILED DISCHARGE TUBE.

* Worthington, A. M., "The Splash of a Drop and Allied Phenomena" (*Proc. Roy. Inst.*, May 18, 1894): "A Study of Splashes" (London, 1908).

cathode discharge tube, which represents a most important advance, we are largely indebted to Edgerton, of the Massachusetts Institute of Technology. A commercial version of the cold cathode discharge tube is the Kodatron Speed Lamp (Figs. 1 and 2). This consists of a discharge tube wound in the form of a helix to give a compact source of light, with a frosted glass container and a reflector. The tube is filled with a mixture of rare gases at low pressure and provided with anode and cathode. The Kodatron is self-contained, with a control box in the base of the stand supporting the reflector. On connecting with the 240 volt A.C. supply and switching on, a bank of condensers is charged to 2,000 volts. Nothing happens, since the gas pressure is adjusted to withstand this potential. The tube contains, however, a third electrode and, on depressing a second switch, this conveys a high-frequency pulse to the tube. The gas is ionized; the sparking potential drops to below 2,000 volts; the current passes between the electrodes and is accompanied by a vivid flash of light. The duration of the flash depends upon the condenser capacity. Using the full capacity of 112 mfd., the flash lasts for 1/5,000 sec. Within the angle of the reflector the luminous output is of the order of 50 million candle-power; and with a fast film and high-aperture lens, photographs can be taken of objects at a distance of 100 yd. from the lamp.

As this lamp demonstrates, electronics have played their part in the advance in the design of light sources. The application of electronics has also enormously simplified the problems of synchronization. If a beam of light is caused to fall upon a photo-electric cell, the cutting of the beam can be made to fire the flash. A microphone connected with the Kodatron illustrates the principle of synchronization by sound. By varying the distance between the microphone and the source of sound, a time lag can be introduced to the extent of 1/1,000 sec. per foot. This is often convenient in projectile photography. The spark can be fired at any predetermined interval of time after the explosion and the bullet thus photographed at any required distance from the muzzle.

Dr. Slack, of the Westinghouse Laboratories, has recently devised an X-ray tube which does not contain a heated filament to provide the source of electrons. It functions in much the same way as Edgerton's cold cathode discharge tube. A burst of current through the tube causes an emission of X-rays limited in duration to a millionth of a second. Bullets can be photographed with this apparatus as they pass along the gun barrel.

So far we have been concerned for the most part with the taking of a single photograph: with snatching a fleeting instant from the passage of time to reveal one phase of an event, and with methods whereby we can ensure that we capture the instant of interest. If we wish to study the whole course of an event, we must turn to the cinematograph. In the high-speed cine-camera the pictures are taken at a much greater rate than that used for projection, and so the event is stretched out in time.

In projection at least sixteen pictures must fall on the screen in each second if flicker is to be avoided and the appearance of continuous motion is to be obtained. The modern high-speed cine-camera will take 3,000 pictures per sec. We are thus able to slow down the motion in the ratio of 3,000 to 16, a factor of about two hundred times. For this reason the high-speed cine-camera is often referred to as a 'time microscope', which, in the case I have quoted, can be said to have a 'magnification' of two hundred times.

In the ordinary cine-camera the film is moved intermittently. This is impossible at high speeds; the film must run continuously and the desired result must be produced in other ways. Edgerton overcomes the difficulty by using his discharge lamp to illuminate the subject by a succession of flashes to give the separate pictures on the continuously running film. The value of the method to modern industry will be obvious.

In industrial applications, however, it is rare that one can bring the problem to the laboratory. We need readily portable equipment, such as the Kodak High Speed camera. The subject is illuminated in the ordinary way, that is, continuously. The film also runs continuously through the focal plane of the lens. Between the lens and the film a block of glass rotates to form a shutter and to provide optical compensation for the film movement (Fig. 3). The glass block is fitted with vanes which form part of the surface of a cylinder and act as shutters. During each revolution, light from the lens is admitted to the film and a photograph is taken. The light is refracted downwards by the glass block as it passes through the vertical position in such a way that the image moves with the film and relative motion is avoided.

At a frequency of 3,000 pictures per second—the maximum speed of the camera—the time of exposure of each photograph is 1/10,000 sec. At this frequency the film is travelling at 75 ft./sec., and, were it not for the optical compensation, the exposure time would have to be reduced to a few millionths of a second to reduce the effects of film movement to negligible proportions. These conditions can be met by Edgerton's flashing lamp technique, but only with sacrifice of illumination. For the analysis of many phenomena, the most important requirement is a high frequency of picture taking: given this, the exposures of the separate pictures can be relatively long, and the ability to expose for so long as 1/10,000 sec., conferred by optical compensation of film movement, greatly simplifies illumination problems which, however, remain formidable enough. Illumination of the subject to a level approximating to sunlight on a fine summer day is necessary.

The camera is comparatively light and compact. It takes a 100-ft. roll of film of the type normally used for amateur cinematography. The base of the camera has been fitted with a timing device. This consists of an electrically controlled 1,000-cycle tuning fork, a small lamp and an optical system which throws an image of the lamp filament on to the edge of the film. The light beam is interrupted by shutter blades attached to the prongs of the fork to give a series of dots along the edge of the film at 1/1,000 sec. intervals.

In the ideal case the photography is simple. However, each problem usually presents special difficulties which must be overcome. A typical example is afforded by an investigation which was carried out of the performance of a drop forging hammer. The hammer weighed 8 tons and the whole machine was based on some 500 tons of concrete. The users were concerned by the slight displacements which took place in this massive base. It was desired to know the extent of movement of the anvil under impact. Observers had put the figure at between $\frac{1}{4}$ in. and 2 in., and we were asked to carry out measurements

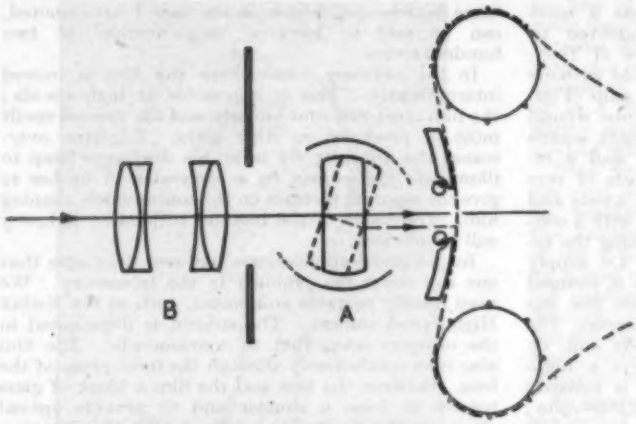

FIG. 3. SCHEMATIC DIAGRAM OF A NON-INTERMITTENT CINE-CAMERA WITH OPTICAL COMPENSATION.

by high-speed photography. The problem would have been simple but for two facts. First, on impact there was a cloud of smoke and flame from the fluxes used in the mould, and the anvil was largely obliterated. Secondly, everything in the vicinity rocked as if by an earthquake, and there was no possibility of insulating the camera from the violent vibrations. Thus it was necessary to include in each photograph some fixed object to which the displacement of the anvil could be referred. This was found in a low-frequency pendulum suspended at the centre of a stretched elastic cord. Vanes attached to the bob of the pendulum dipped in an oil bath and prevented any other than vertical motion. The low frequency of the pendulum—of the order of 2 sec.—prevented it from moving until long after the impact. Thus movements of the anvil only were recorded. A vane on top of the pendulum partly obliterated the image of a bright light source reflected into the camera from a prism which was fixed in the anvil. When the anvil moved, the slit image of the light source widened and narrowed, and these movements were photographed. An analysis of the photographs showed that the movement ended in 1/200 sec. and the maximum displacement was 1/20 in.—five times less than the lowest visual estimate.

Sometimes it is the analysis of the records, and not the photography, which presents unusual difficulties. An ingenious method to overcome them is due to the L.M.S. Railway Research Laboratory. In an investigation of the influence of the profile of the carriage wheel on the smoothness of running of a train, it was desired to measure the sideways motion of the wheel on the rail during travel. Arrangements were made to take a cine-picture of the point of contact of rail and wheel. On each of the many thousands of photographs obtained, the displacement had to be measured—an almost impossible task by ordinary means. The special apparatus which was devised allowed the measurements to be made easily and quickly. In place of the usual cine-projection screen, a 'recording screen' was used, and during projection of the film the recording paper was moved synchronously with the passage of the film through the projector. One observer by means of a lever was able to move the whole screen bodily sideways to keep the image of the rail against a datum line. Another observer kept an index on the image of the wheel and made a trace on the paper. The distance of this from the datum line gave the required information—a kind of 'indicator diagram' on the recording screen which could be evaluated mathematically.

These two examples of the way in which physical devices are used to overcome experimental difficulties must suffice. I am very conscious of many omissions. I have not mentioned Sir Charles Boys' ingenious lightning camera which, in the hands of Schonland and others, has been so fruitful in the analysis of the lightning discharge. I have not mentioned the large amount of work on flame propagation which has resulted in the unravelling of many of the mysteries of combustion by Ellis, Bone and Frazer, to mention three outstanding workers in Great Britain.

My excuse must be that the possibilities of wedding experimental ingenuity to photography are almost boundless. Another omission is the analysis of very slow phenomena. Perhaps here I may plead that there is no problem. There is no difficulty in taking photographs with intervals of minutes or days. The film is projected at normal speed and the passage of time is telescoped. In this way much light has been shed upon such phenomena as cloud formation, the growth of plants, the opening of blossoms, etc.

AREA AND NUMBER OF SPECIES

By DR. C. B. WILLIAMS
Rothamsted Experimental Station

FOR many years there have been discussions of the relation between the size of a sample of an animal or plant community and the number of species contained in it. Until recently, however, most of the approach has been from the botanical side.

So long ago as 1859 Watson[1] gave a table of the area and number of species of flowering plants in each of the 18 provinces and 38 sub-provinces into which he divided Great Britain, and commented on the fact that one square mile of diversified country in the north of Surrey contained nearly half the species of plants of the whole 760 square miles of the county. Much later, Willis[2] touched on the same problem from a slightly different angle, as he was more interested in the frequency of species with different distributions than with the actual number of species in one area. The question was then taken up by Arrhenius, Gleason and others by the use of the quadrat system of examining very carefully all the plants on a number of quite small areas as a random sample of the whole.

Arrhenius[3] considered that the relation between area (A) and number of species of plants (S) on various sizes of plots in the same botanical association was given by the formula A varies as $(S)^n$ where n is a constant for the population under consideration. Rich types (that is, associations rich in species) have a low n value and poor types a high value, but the range of n was quite small. This relation should give

a straight line when the log of the area is plotted against the log of the number of species. On the whole the fit of Arrhenius's calculated figures to the observed numbers was not good, and in some examples, especially for rather large areas, very poor indeed.

Gleason[4] studied data from a number of plots of different sizes in an aspen association in Michigan. He came to the conclusion that a straight-line relationship was obtained when the log area was plotted against the actual number of species, and not its logarithm: otherwise that A varies as n^S. This gave a distinctly better fit than Arrhenius's figures for larger areas, but when extrapolated towards the smaller areas gives the curious result that certain small areas must have no species—or even less than none!

Both these theories were developed empirically to find a graph to fit certain observed results, and they were not based on mathematical reasoning.

In all the work on plants, the areas have been the basis of comparison between two or more samples. Plants are sedentary, so that it is easy to decide which plants belong to any particular area; and within one ecological association the number of individuals is probably proportional to the area. On the other hand, it is difficult in many species of plants to decide where an 'individual' begins and ends. In animals the reverse is the case; it is nearly always possible to recognize the individual; but, owing to their mobility, it is difficult to say which animals belonged to which area, particularly if this is small.

The problem of the relation between the number of individuals and the number of species in a random sample of a mixed animal population has been recently taken up. R. A. Fisher has developed a mathematical theory of sampling, based on certain assumptions as to the frequency distribution of different species in the population sampled; and I have shown that these conclusions are very closely supported by results obtained in the field by random samples of insects in a light-trap[5].

Fisher's work suggests that the relation between the number of species (S) and the number of individuals (N) in random samples of a mixed population is given by

$$S = \alpha \log_e\left(1 + \frac{N}{\alpha}\right).$$

The value α is a constant for the population and we have called it the Index of Diversity. It is large for populations rich in species and small for those with few species, and it has a very considerable range of values in observed samples.

If for any one sample from a mixed population we know the number of individuals and the number of species, then α can be calculated, and hence we can find how many species would be represented in any other sized sample from that population. Fig. 1 shows the observed numbers of species of Lepidoptera in samples of eight different sizes taken by means of a light-trap at Harpenden during the years 1933–36. The same diagram shows the calculated relations for various values of α, and it will be seen how closely the observed figures are to the calculated values for $\alpha = 40$. Even the slight departure from this theoretical curve can be explained by the fact that sampling covered several years.

It will be noted that, in Fisher's formula, if the size of the sample N is large compared with α, then

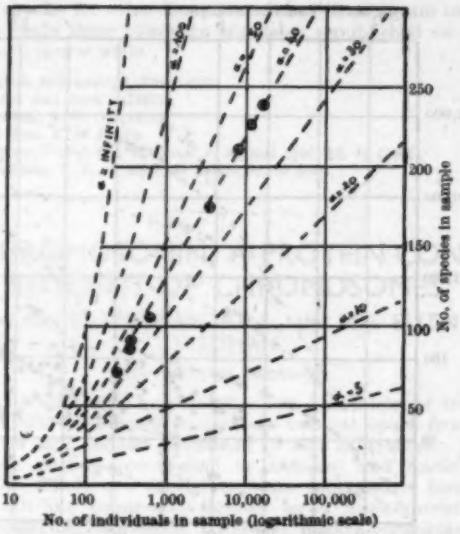

Fig. 1. The relation between the number of individuals and the number of species in samples of different sizes, according to Fisher's logarithmic series, for different values of the Index of Diversity 'α'. Also the observed values for 8 samples of different sizes for Lepidoptera captured in a light trap at Rothamsted.

the 1 can be neglected in relation to $\frac{N}{\alpha}$ and S is proportional to $\log_e N - \log_e \alpha$. Otherwise (since $\log_e \alpha$ is a constant for the population) for large samples there is a straight-line relation between the number of species and the log size of the sample, just as suggested empirically by Gleason for plants. For smaller-sized samples, Fisher's formula departs from the straight line and is a much closer fit to the observed facts (see Fig. 1). Some botanical applications of this theory are discussed in a paper at present in the press[6].

This formula gives an apparently sound basis for calculating the relation between the number of species and the size of the sample (either as numbers of individuals or as area) provided that the samples are taken from the same population in the same ecological association. If, in the course of increasing the size of the sample, we extend into a different population or ecological area the number of species will increase more rapidly.

It occurred to me that it would be interesting to see what changes in the number of species were in fact found when the size of the sample was increased far beyond the limits of single ecologically uniform populations. As the number of species concerned is likely to be very large, it was necessary to use for the purpose a diagram showing both species and size of samples on a logarithmic scale, although this does not give a straight-line relationship for sampling from the same population. As plant data appeared to lend themselves better for this study, and to be available in greater quantity, it was decided to plot the number of species of flowering plants against the area sampled over the greatest possible range of areas, from very small to very large.

The results of this investigation are shown in Fig. 2. The heavy central vertical line of the diagram represents one square kilometre of land: to the left

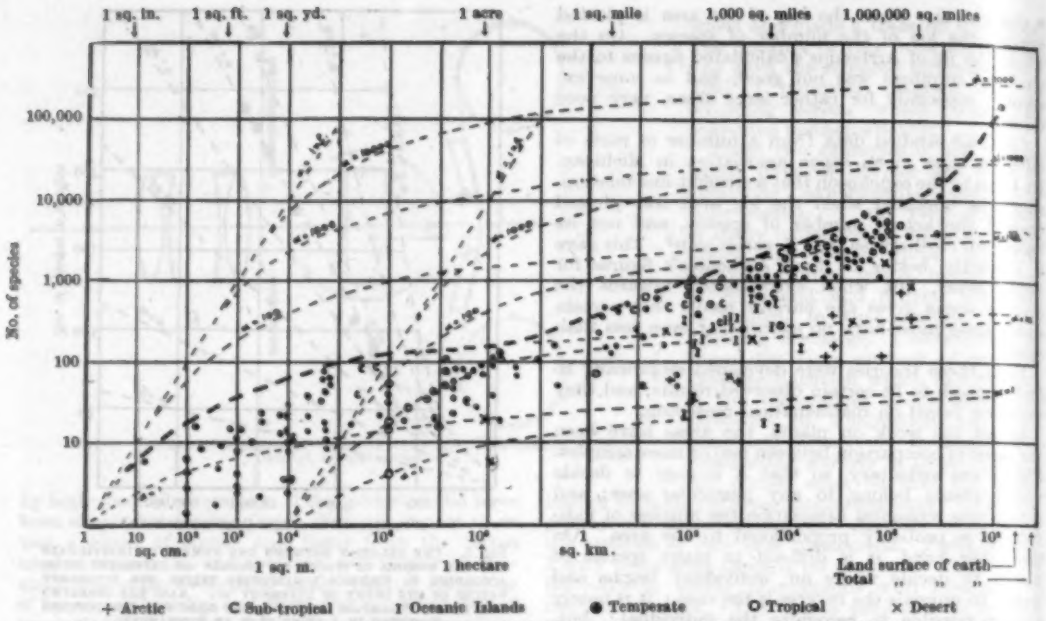

Fig. 2. DIAGRAM SHOWING THE RELATION BETWEEN THE AREA OF A LOCALITY AND THE RECORDED NUMBER OF SPECIES OF FLOWERING PLANTS FOR THAT AREA.

from this the vertical lines represent 1/10, 1/100, etc., of a square kilometre until we reach 1 square centimetre on the extreme left. Moving to the right, we have vertical lines representing 10, 100, 1,000, etc., square kilometres until the one at the right overpasses the total area of the earth's surface. The horizontal lines represent 1, 10, 100, etc., species found in the areas under discussion.

Each point on the diagram represents an actual area of land from which the number of species of flowering plants has been recorded. It was not possible to reproduce here a diagram sufficiently large for each point to be identified to its exact location, so instead they have been distinguished into the chief climatic regions with separate indications of oceanic islands and deserts. The points are not quite evenly distributed throughout the range of the diagram: there is a particular lack of records of areas between two acres and a square mile; and I have only been able to find estimates of the total flora for two continents, North America and Europe. There is a lack of records for small areas both from the tropics and in the arctic and sub-arctic climates. Many records could not be used because the exact limits of the area were not well defined. In general there is probably a tendency to underestimate the number of species; but, except in a few areas that have been very little studied, the number likely to be added will make very little difference to the position of the record on the logarithmic scale. An increase of 10 per cent in the number of species will only move the point upward through approximately its own diameter.

Superimposed on the diagram by dotted lines are the lines of increase of number of species with size of sample expected by Fisher's theory of randomized sampling in a uniform population (*loc. cit.*). This theory depends on the number of individuals in the sample, and while in general the number of individual plants is proportional to the area sampled, this is not true when we compare grassland with woodland, or woodland with desert or arctic conditions. Available information indicates that there is about 1 plant per square cm. in temperate grassland, about 1 per square metre in woodland, and 1 per 100 square metres upwards in semi-desert areas. The relations on Fisher's series are shown for several different values of the Index of Diversity 'α', and starting from the base line of 1 plant per sq. cm. and 1 per square metre. It will be seen that the lines for the same α values from these two bases gradually approach as the area increases, and for very large areas the number of species to be expected is not very different whether the plant population is dense or sparse. In the extreme case with $\alpha = 1$ there would only be about thirty-four species in the whole world with 1 plant per square metre, and about forty-two with 1 plant per sq. cm. if the whole world were a uniform ecological association.

Returning to the distribution of the points on the diagram, it will be seen that they are chiefly scattered over a narrow belt across the figure, the upper limit of which can be divided roughly into three parts. First a period of rapid rise steadily falling away, from the smallest areas of a few square inches to about one or two acres, or one hectare. Secondly, a range of steady rise, almost linear, lasting from about one hectare to large continental areas of about five million square miles. Finally, a very rapid rise from the continental areas to that of the whole land surface of the globe.

It seems to me that these three portions of the limiting curve can be explained as follows. The first part, as will be seen from the diagram, very closely follows the curve for $\alpha = 10$ of Fisher's theory with about 1 plant per sq. cm. Otherwise this portion

follows the expected increase in species due to increase of size of sample within a uniform population, or within a single ecological association. In other words, up to areas of the order of one or two acres, neither the climate nor the rest of the environment changes very rapidly on an average. As soon as we pass beyond this limit we begin to include new ecological conditions in our sample, with the result that the number of species will increase more rapidly than would be expected if the population sampled remained uniform. This is the second portion of the curve, and the increase of species continues steadily as we increase the size of samples, gradually including more and more variety of ecological formation due either to climate, soil, slope or other differentiating cause. This process continues until we reach the approximate limits of the continents. The slope of this linear portion of the boundary is such that an increase of 1 in the log number of species corresponds to an increase of about 5 in the log area. Otherwise it appears, empirically, that over this range the optimum number of species increases approximately as the fifth power of the area; to double the number of species the area must be increased by thirty-two times.

When we add continents together to get the flora of the whole world, an entirely new factor comes in, that of the evolutionary origin of the floras. Fewer species are common to two continents than to two halves of the same continent. The floras have evolved differently. Therefore, on adding two continental areas together we get a sudden increase on the number of species, far beyond that due to the increase of ecological variety within the area. This is the last steep portion of the curve.

Thus the inverted S-shaped form of the boundary of the belt of points appears to be consistent with the known facts of sampling technique, ecology and evolution.

The position of the points within the belt can be used for pointing out resemblances and differences which may be of great interest. It will be seen, as might be expected, that the tropical and subtropical areas have in general rather more species on the same areas, but the temperate areas run them very closely. On the other hand, the lower portion of the belt is largely made up of floras of either arctic areas, deserts or oceanic islands. The two isolated 'I's' between 10^3 and 10^4 square kilometres are Kerguelen Island and South Georgia, both oceanic islands with, in addition, a sub-arctic climate. If a much larger number of points could be obtained it would be of interest to tabulate each type of climate separately—and possibly to distinguish some of the different associations, such as forest and steppe, which cover large areas.

It is possible from this type of diagram to make rapid comparisons between areas of similar size with different numbers of species, and between areas with the same number of species but different sizes; and new areas can be placed on the diagram and rapidly assessed in relation to those already known.

This enables one to take in a comprehensive view of a range of phenomena which has been insufficiently studied; and also makes it possible to make rapid comparison between the richness of flora of different areas, at the same time allowing for the differences in size. Up to the present it has been easy to compare floras of similar areas but very difficult if they were dissimilar.

I should be glad of any data of area and number of species for other localities so that the diagram can be made more complete and later republished on a much larger scale.

[1] *Cybele Britannica*, **4**, 379 (1859).
[2] "Age and Area" (1922).
[3] *Ecology*, **4**, 68, 90 (1923).
[4] *Ecology*, **6**, 66 (1925).
[5] Fisher, Corbet and Williams, *J. Animal Ecol.*, **12**, 42 (1943).
[6] Williams, C. B., *J. Ecol.*, **31** (1943), in the press.

CHROMOSOMIN, A PROTEIN CONSTITUENT OF CHROMOSOMES

By DR. E. STEDMAN, F.R.S., and MRS. ELLEN STEDMAN
University of Edinburgh

ACCORDING to current views, the nuclei of the cells of animals and plants consist, apart from water and lipoids, essentially of two substances: a basic protein (protamine or histone) and nucleic acid. These two constituents are supposed to form a salt-like compound, known as a nucleoprotein (protamine or histone nucleate), which constitutes the so-called chromatin of the nucleus. The results upon which these views are based have been largely derived from chemical studies of the heads of fish spermatozoa. Thus Miescher[1], the pioneer worker on this subject, calculated that the dried heads of salmon spermatozoa contained as much as 96 per cent of salmine (protamine) nucleate, while H. Steudel and Peiser[2] claimed to have reconstituted the nucleoprotein of herring sperm (that is, the dried heads) by the simple expedient of mixing solutions of equivalent quantities of clupein sulphate and deoxyribose-nucleic acid, the protamine having been prepared from herring sperm itself and the nucleic acid from the thymus gland. Other data of a confirmatory nature have been published by various authors, and the results so obtained from the investigation of fish sperm have been generalized and applied to all nuclei, largely on the basis of their histological similarity.

According to a recent review of the subject in NATURE[3] which should be consulted for further references to the literature, this conception of the composition of the nucleus still holds for ripe sperm and for nuclei with chromosomes in metaphase, although in the resting nucleus the euchromatin is believed, on the basis of the ultra-violet absorption spectra determined with the quartz microscope by Caspersson, to contain a small amount of a protein of the globulin type. Some doubt has, however, been raised[4] as to the possibility of distinguishing proteins in nuclei by this method.

These opinions regarding the chemical composition of the nucleus are, however, incorrect.

In the course of investigations which have extended over several years, we have succeeded in isolating from nuclei, in particular from fish sperm, not only a histone (or protamine) and deoxyribosenucleic acid, but also a protein of a new type which we have no hesitation in saying represents quantitatively the major constituent of the nucleus. As will be shown below this protein constitutes the chromatin of the nucleus and hence forms the principal component of the chromosomes. On this account we suggest for it the name of chromosomin. According to geneticists, the chromosomes are the transmitters of

hereditary characters. If this is the case, it is evident that chromosomin must play a major part in such transmissions.

Chromosomin is present in all the animal nuclei which we have so far examined. We have not yet determined whether its composition varies with the species from which it is isolated; such variation is, however, to be expected. Nevertheless a protein with the same general properties has been isolated from both cod and herring sperm, from the nuclear material obtained from ox spleen and from the nuclei present in the Walker rat carcinoma.

The most detailed examination of it which we have so far been able to carry out has been made with the chromosomin from cod sperm, and the following data refer in particular to this substance. As isolated from the nuclei it possesses predominantly acidic properties. It is soluble in alkalis and can be precipitated from the solutions so formed by the addition of acids. When free from salts it is dissolved to some extent by dilute acetic acid, but the solution tends to set to a gel. Owing to its insolubility in acetate buffers (about *p*H 3·0–5·0) we have not yet been able to ascertain its exact iso-electric point, but this evidently lies somewhere between these *p*H values. About 25 per cent of the molecule is composed of basic amino-acids, there being present arginine (9·5 per cent), histidine (5 per cent) and lysine (11 per cent). The value for arginine is, we believe, quite accurate; those for histidine and lysine may require slight adjustment in the future, but such adjustment, if necessary, will only involve a change in the relative amounts of the two amino-acids. The acidic properties which chromosomin possesses, despite its high content of basic amino-acids, are almost certainly due to the presence in the molecule of relatively large amounts of glutamic acid, which substance we have isolated in a pure crystalline state from its hydrolysis product. Aspartic acid has similarly been isolated, although in smaller amount. Chromosomin is also characterized by its relatively large content of tryptophane. Other mono-amino-acids, including cystine (0·4 per cent), are also present, but their identity has not yet been ascertained. A small amount of labile sulphur is lost from the nuclear material during the isolation of chromosomin; the origin of this is, however, undetermined.

That chromosomin represents the principal component of the chromosomes is readily shown by staining experiments. For this purpose we have used a preparation dried by successive treatment with alcohol and ether and so rendered completely insoluble in water. When such material, which corresponds to the fixed tissue of the histologist, is placed in a solution of a basic dye (for example, methylene blue, gentian violet) it takes up the latter by virtue of its acidic properties, and on repeatedly washing the centrifuged material with water, the dye is slowly removed. In this respect the behaviour of chromosomin parallels that of the chromatin in the nucleus. Other acidic proteins would, no doubt, behave similarly; chromosomin is, however, the only protein of this type present in any considerable amount in the nucleus.

But perhaps the most convincing evidence of the identity of chromosomin and chromatin is its characteristic behaviour towards hæmotoxylin. When stained with this dye it assumes the typical blue colour familiar to histologists. The stain is, moreover, very firmly held despite repeated washings with water. Casein, an acidic protein not found in the nucleus, is also stained by hæmotoxylin, but in this case the material assumes a purple colour which is quite distinct from the characteristic blue produced with chromosomin. There can, we think, thus be no doubt that the staining properties of chromosomes are due to the chromosomin in these nuclear organs.

It is, we believe, generally assumed that nucleic acid, the only acidic component of the nucleus hitherto known, is mainly, if not entirely, responsible for its behaviour towards basic dyes, and on this postulate the hypothesis has been developed that the chromosomes are largely composed of this acid. This hypothesis receives apparent confirmation from the results obtained with Feulgen's stain. It is, in fact, now generally believed that Feulgen's reagent which, according to its discoverer, reacts specifically with the hydrolysis product of deoxyribosenucleic acid, is capable not only of detecting nucleic acid in the nucleus but also of locating its actual position. While there is little doubt that Feulgen's reagent is of great service in detecting deoxyribosenucleic acid, the idea that it can locate the position of this material in the nucleus is based on a misconception of the processes involved. The stain, whatever its exact nature may be, liberated from the reduced magenta by the hydrolysed nucleic acid, is freely soluble in water. Hence, once it has been formed in the nucleus, it is capable of behaving exactly as do other basic dyes. Apart from the necessity of hydrolysing the nucleic acid before the application of the stain, Feulgen's technique differs from ordinary staining technique merely in the fact that the stain is developed inside the nucleus in limited amount and is not applied from outside. That this explanation is correct can be readily demonstrated. If some hydrolysed deoxyribosenucleic acid is treated with Feulgen's reagent and the mixture allowed to stand until the colour is fully developed, a clear solution with a purple colour is obtained. If some chromosomin is now introduced into this solution, it takes up the dye in exactly the same way as do the chromosomes, assuming a purple colour with a much bluer tinge than that of magenta itself.

The staining properties of the chromosomes towards both basic dyes and Feulgen's reagent are thus due to their content of chromosomin, and the evidence indicating the presence in them of nucleic acid is shown to be fallacious. Nevertheless, we do not wish to claim that the chromosomes are composed entirely of chromosomin. Other undetected substances may be present in small amount, and the facts we have adduced do not exclude the presence of some nucleic acid. A consideration of some quantitative data, however, points to the conclusion that at least part of the nucleic acid is exterior to the chromosomes. Thus, of the three main components of dried nuclei, namely, chromosomin, nucleic acid, and histone, the last two can be estimated with a fair degree of accuracy, the histone by direct isolation and the nucleic acid by a determination of the phosphorus content. Making the assumption, which we believe to be substantially correct, that the remainder of the material consists of chromosomin, we arrive at the composition of the nuclei.

The following results were obtained in this way:

Nuclei	Nucleic acid	Histone	Chromosomin
Cod sperm	28%	12%	60%
Ox spleen	34%	16%	50%
Walker rat carcinoma	26%	1·6%	72·6%

It should be emphasized, however, that the composition of the nuclei is not constant. Some specimens of cod sperm which we have examined have, for example, contained as much as 23 per cent of histone, while the nuclei from the rat carcinoma have sometimes failed to yield any histone at all. The figures do, however, indicate that chromosomin forms the largest constituent of the nucleus, and since it represents the characteristic substance of the chromosomes, there would appear to be little material left to form the nuclear sap unless this contained some nucleic acid. It is an attractive hypothesis, but one for which there is no direct experimental proof, that the spindle which is formed at metaphase is a gel of nucleic acid. The attachment of the chromosomes to the equatorial plate of the spindle could then be conceived as involving perhaps the acidic groups of the nucleic acid and basic groups of the chromosomin, the acidic groups of the latter being neutralized by the histone. Alternative methods of combination are, of course, possible. But the important experimental fact is that the nucleus is composed of at least three amphoteric substances: chromosomin, nucleic acid and histone (or, in special cases, protamine), two of these possessing predominantly acidic properties and one, the histone, predominantly basic properties. Between three such substances a number of salt-like unions could be formed, the nature of which would be controlled by the acidity of the medium in which they existed. It is not, however, our present purpose to speculate on the nature of the changes which occur in the nucleus; discussion of this and other aspects of our work will be reserved until it is possible to give a more detailed account of our experiments.

We desire to thank Dr. A. Haddow of the Chester Beatty Cancer Research Institute for providing us with the Walker carcinoma tissue, and the Medical Research Council for a grant to one of us.

[1] Miescher, F., "Die histochemischen und physiologischen Arbeiten" (Leipzig, 1897).
[2] Steudel, H., and Peiser, E., *Z. physiol. Chem.*, **122**, 208 (1922).
[3] Darlington, C. D., NATURE, **149**, 66 (1942).
[4] Minsky, A. E., "Advances in Enzymology", **3**, 1 (1943).

OBITUARIES

Sir Stopford Lauder Brunton, Bt.

SIR STOPFORD BRUNTON, who died on July 25, was the elder son of the late Sir Thomas Lauder Brunton, the eminent physician. He was born on October 11, 1884. He was educated at Cheltenham College, from which he went to the Royal Military Academy, Woolwich, and later to McGill University, Montreal. There, after studying mining geology, he took his degree in 1912. He worked on the Canadian Geological Survey until the War broke out in 1914. Holding a commission in the O.T.C., he drew up a scheme of military training which was accepted at Ottawa, and led to his being sent to France to study modern methods of field-defence. On his return to Canada he raised No. 6 (McGill) Heavy Siege Battery, recruited from graduates and undergraduates of the University, and as officer commanding, took his unit to France in 1917, remaining on that front until the end of the War.

For the next six years Sir Stopford was engaged on survey and mining in Nova Scotia. The results of his work were embodied in two publications, the second of which, "The Gold Deposits of Nova Scotia: a New Hypothesis concerning the Structural Features of the Province", published in 1925, was awarded the Leonard Gold Medal for 1927, jointly by the Engineering Institute of Canada and the Canadian Institute of Mining and Metallurgy. Sir Stopford, in spite of failing health in recent years, was keenly interested in agricultural progress in Nova Scotia, where he owned a farm.

Inheriting the high ideals of his father and something of the fine quality of his genius, he had much personal charm and a kindly, unselfish, generous nature, to which the affectionate devotion of his friends and former comrades offers a fitting tribute. Sir Stopford married in 1915 Elizabeth, daughter of Prof. J. Bonsall Porter of Montreal, and leaves a son and a daughter. The former is now serving in the Royal Canadian Army Medical Corps.

Dr. A. C. Klebs

DR. ARNOLD KLEBS, the eminent Swiss medical historian, died on March 6 at Nyon, on the Lake of Geneva. Born on March 17, 1870, the son of Prof. Edwin Klebs, the famous bacteriologist who was successively professor of pathology at Bern, Würzburg, Prague, Zurich and Chicago, received his medical training at Bern, Kiel, Würzburg and Berlin, and qualified at Basle in 1894. After post-graduate work in London and Paris, he went to the United States at the age of twenty-six. He gained a reputation by his work on tuberculosis, for which he founded a sanatorium in Alabama and a tuberculosis institute in Chicago. Afterwards he made the acquaintance of the late Sir William Osler, who inspired him with an interest in the history of medicine.

One of Klebs' earliest articles on this subject was the history of inoculation against smallpox (1913). Eventually he published a large number of medico-historical essays either independently or in collaboration with Sudhoff, to whom he devoted a remarkable article on Gianmatteo's "Practica" in the *Festschrift* in honour of Sudhoff's seventieth birthday.

In 1921 Klebs played an active part in the foundation of the Swiss Society of the History of Swiss Medicine and Sciences, which holds a congress regularly every year. In 1938 he published a standard work, "A Short Title List of the *Incunabala scientifica medica*". His last great work was a bibliography of the writings of his friend Harvey Cushing, which appeared on the occasion of the seventieth birthday of the great brain surgeon. His own seventieth birthday was celebrated by Prof. Henry Sigerist, of Baltimore, in a *Festschrift* which appeared in the *Bulletin of the History of Medicine* in 1940. His last years were embittered by the War, which deprived him of the visits of his friends in Europe.

J. D. ROLLESTON.

WE regret to announce the following deaths:

Prof. F. Bacon, professor of engineering in University College, Swansea, on August 23, aged sixty-two.

Prof. W. G. de Burgh, F.B.A., emeritus professor of philosophy in the University of Reading, on August 27, aged seventy-six.

Prof. John Hilton, professor of industrial relations in the University of Cambridge, on August 28, aged sixty-two.

NEWS AND VIEWS

The British Council

THE report of the British Council for the year ending March 31, 1943 (London: British Council, pp. 108), indicates a steady expansion of the work of the Council making known the life and thought of Britain abroad. The detailed description of the exchange between this and other countries of information on the work of men of science, doctors, engineers, teachers, lawyers, trade unionists, scholars, musicians and artists given in the report indicates the way in which the Council is helping to bring about a real place of understanding by the people of the peoples of the world and the increasingly important place of the Council's work in the United Kingdom in relation to the future of Europe. The Council is responsible for the educational and cultural welfare of the Armed Forces of our European Allies stationed here, for that of Allied neutral merchant seamen reaching our ports, and for that of foreign civilians, and the facilities for instruction and recreation made available have proved no less welcome to the Armed Forces of the Dominions, in particular the Canadian Army and Royal Canadian Air Force and soldiers, seamen, technicians and others from the British Colonies and India. The Conference of Allied Ministers of Education which was initiated at the suggestion of the Council has appointed two Commissions—one to consider the negotiation of bilateral treaties of understanding or cultural conventions and the other to report and make recommendations on questions affecting the supply of books and periodicals to the occupied countries of Europe after the War, including the restocking of national and university libraries destroyed or damaged by the Germans, the provision of text-books for university students and for schools, and a brief factual history of the War. In Turkey a number of university appointments were made by the Turkish authorities on the Council's recommendation, including that of Dr. F. A. Constable to the chair of physical chemistry at the University of Istanbul. An exhibition of photographs of British scientific achievements was opened at Istanbul, and in the Soviet Union the recently established scientific bureau of the U.S.S.R. Society for Cultural Relations has appointed the head of the Council's Science Department as its agent for the supply of information about science and scientific workers in Britain. A number of articles have been written especially for the Scientific Bureau by Sir Stafford Cripps, Dr. Julian Huxley, Dr. C. D. Darlington and Mr. J. G. Crowther.

With regard to science, in addition to continuing the issue of *Monthly Science News*, a series of broadcast talks have been arranged or advised for the B.B.C. Overseas Service and a number of volumes published in the "Science in Britain" series. Arrangements were made for the medical abstracts prepared by the British Medical Information Service to be printed under the title of *British Medical Bulletin*, and these abstracts are sent to the editors of overseas medical journals in English, Spanish and Portuguese. A number of original articles, commissioned from British medical experts, have been published or accepted for publication in medical journals of good standing. Considerable attention has been given to medical films. The Medical Department of the Council is answering an increasing volume of general medical inquiries from other countries. The Engineering Panel has advised on questions affecting technical education in Turkey and articles on engineering science have been forwarded to Turkey, Egypt, the British West Indies and elsewhere. Many foreign universities and educational authorities rely on the Council to recommend British scholars or research workers to fill University appointments abroad, and the Council has also participated in the training of Allied personnel for reconstruction, a number of scholarships having been awarded in collaboration with the Allied Governments for post-graduate and undergraduate study, and a further course has been arranged in London for Allied civil servants, with lectures on British administration and classes on British diplomatic and legal terminology.

The Council has continued its policy of presenting books to increase the libraries of British institutes and anglophile societies, in universities, schools, libraries and other institutions abroad, and in the United Kingdom to British subjects from the Empire and foreign lands, a very substantial proportion of the books sent abroad being of a scientific, technical and specialized kind. The Council has continued to take a direct interest in the export trade of books both by encouraging the sale of British books of cultural value in foreign bookshops, conducting its exhibition of books which have a commercial as well as a prestige value, facilitating the review of British books in the foreign press and arranging for the publication of more British books in the original or in translation.

Review of the Aircraft Industry

THE tenth report of the 1942–3 session of the Select Committee on National Expenditure pays brief tribute to the remarkable industrial achievement of the aircraft industry. The production of aircraft is now substantially balanced, and, with the exception of spares, there is at present no single field of production where a serious bottleneck threatens to retard output. Most of the Committee's recommendations are minor, but taken together they suggest that there is still room for considerable all-round improvement in the efficiency of the industry. Better personnel management, for example, should assist in reducing an excessive turnover of labour. Again, the industry is suffering from an acute shortage of scientific and technical men and there are not enough adequately qualified men to maintain the industry at the proper level of efficiency, this applying also in the whole field of aeronautical research. Special measures are necessary and men of high academic, scientific or technical attainments should not, in the Committee's view, be allowed to be absorbed in the fighting services, where, even when they are employed in technical jobs, their qualifications are often much higher than is needed. Facilities should be provided for training scientific and technical personnel as well as for training managerial staff of all grades, including foremen, and more use made of the Ministry of Labour's courses in foremanship.

In regard to the dissemination of scientific and technical information the Committee considers that bearing in mind the limitations upon publication which the need for secrecy imposes, the arrangements on the strictly scientific side are adequate. Firms who are in difficulties with regard to technical problems can get the fullest possible help from other firms, but for reasons of prestige are sometimes

reluctant to apply for help. In the less technical problems firms are not always ready to profit by the experience of others, and the report comments on the aircraft industry's neglect of statistical methods of quality control. Other recommendations for improving efficiency include the strengthening of design staffs by the appointment of draughtsmen with actual experience of production engineering, and arranging that design and development offices and planning departments are within the same premises and housed as close to each other as possible. More appointments similar to that of the technical advisor to the chief executive should be made, even if it involves the temporary withdrawal of men occupying important positions in the industry. In regard to the co-ordination of production with research and development the report notes that the importance of this requirement has lately received greater recognition, and strenuous efforts are made to this end through weekly meetings of the controller of research and development with the officers responsible for production. The advantages of collective consultations on the allocation of orders in important changes of programmes are stressed and also the necessity for close attention to the problem of reducing the loss of output caused by change-over from an old to a new type.

Dr. Carl Voegtlin

DR. CARL VOEGTLIN has resigned from the directorship of the National Cancer Institute, U.S. Public Health Service. Dr. Voegtlin, who has been director of the Institute since its foundation in 1938, is sixty-four years of age. He has recently been presented with a portrait of himself at a meeting of the U.S. National Cancer Advisory Council. Before taking over as director of the National Cancer Institute, Dr. Voegtlin had been chief of the Division of Pharmacology in the National Institute of Health. He went to that Division of the U.S. Public Health Service in 1913 from Johns Hopkins Medical School, where he had been associate professor of pharmacology. Born in Switzerland and educated in the Universities of Basel, Munich, Geneva and Frieberg, Dr. Voegtlin has had a distinguished career, and an international reputation for his researches in physiology, pharmacology and cancer.

Summer School in Biology and Health

APPROXIMATELY 250 students attended the Summer School in Biology and Health of the Central Council for Health Education held during August 4–14 at the Chelsea Polytechnic, London. They represented a very wide variety of educational activity, including junior, senior and secondary school teachers, head teachers, training college lecturers, health visitors and nurses, educational administrators, teachers of physical education and domestic science, and representatives of commercial houses. This mixture of different categories was particularly valuable in discussion, since it enabled the various points of view to be expressed. These discussions, and particularly those on sex education, were most fruitful. During the School, students visited experimental stations, health centres and clinics, and there were demonstrations of biological experiments, health education pamphlets and teaching material. In addition, there was a display of text-books and shows of biological and health education films.

Among the lecturers at the School were Dr. Charles Hill, who gave the inaugural address on "Biology and Health", Prof. C. W. Valentine and Prof. Lancelot Hogben of Birmingham University, who spoke on "Early Childhood" and "Biology as a Social Science" respectively. Miss Enid Blyton described "Education Through Story Telling", Miss F. Brackenbury gave an address on "Practical Methods in Health Teaching", Prof. J. R. Marrack spoke on "Social Aspects of Nutrition", Mr. L. J. F. Brimble lectured on "Social Studies and World Citizenship", and Sir John Russell gave the final address, on "Agricultural Developments in the U.S.S.R." The demand to attend the School was so great that many prospective students had to be turned away, and it is likely that next year more Schools will be held both in the North and in the South of England.

Sociological Value of Family Meals

FAMILY table talk plays a vital part in rearing children. During mealtime, the time when the whole family is likely to be together, children learn moral values, absorb family culture, and develop as individuals, according to Prof. J. H. S. Bossard, of the University of Pennsylvania (*Amer. Sociol. Rev.*, June 1943). The dining-room is often the real social centre of the household, and the family is apt to be at its greatest ease at the dining table. The influence of conversation at this time is subtle and intangible, but the part which it plays in rearing children is most important.

Mary's place in the family group becomes most clearly defined and the family serves as her sounding-board during meal-time. Both in the responses given and withheld, the family carries great weight in the moulding of her personality. It is here that the individual members aid in enlarging each other's vocabulary, and "facility and quickness in expression constitute the price for admittance to the conversation", states Dr. Bossard. The family dining table is likened to a clearing house for information, news, and experiences. In some families, according to Prof. Bossard, meal-time serves as a forum, sometimes it substitutes for class-room instruction, and again it may be the one place where problems of importance to the entire family are thrashed out. A child's interests can be stimulated and directed during meals. If Mary has artistic, literary, or mechanical interests, family table talk can either increase or dampen the development of these interests.

Almanacs and Health Education

ACCORDING to an editorial in the February issue of the *Boletín de la Oficina Sanitaria Panamericana*, almanacs have recently been revived as a means of health education. The Division of Malariology in the Argentine, for example, lately used this device in its anti-malarial campaign, and in Venezuela the Ministry of Public Health and Social Welfare published health calendars in 1940. The calendar reaches every social level, including peasants, schools, industrial groups and every public and private institution. A national calendar may include among other items notes on scientific advances of general interest, radio progress, museums, periodicals, ways of preparing food, vaccination, rules for maternal and infant hygiene, social security legislation and economic data.

Insect Pests of Stored Products

The British Museum (Natural History) has recently issued a useful illustrated pamphlet (Economic Series No. 15) entitled "Common Insect Pests of Stored Food Products". Every year many inquiries relating to pests of this kind are received by the Museum. Usually the identification of such pests is not a matter of much difficulty, whereas the giving of advice on control measures is often very far from being easy and straightforward. The provision of this kind of advice is not properly the concern of the Museum staff, and, for this reason, the Trustees have welcomed the recent establishment of a Pest Infestation Laboratory by the Department of Scientific and Industrial Research and of an Infestation Branch under the Ministry of Food. The present booklet has been prepared at the request of these two organizations, and it aims at making easy the identification of the insects and arachnids commonly associated with stored products in Great Britain. The authors, Drs. H. E. Hinton and A. Steven Corbet, have avoided the use of any but the most elementary technical terms, so that the layman—apart from the entomologist—should be able to identify most of the pests that he is likely to come across. The pamphlet is obtainable, price 1*s.*, through a bookseller.

Protective Finishes for Scientific Apparatus

The June issue of the *Journal of Scientific Instruments* consists mainly of three papers which constitute a symposium on "Protective Finishes for Scientific Instruments and Apparatus". In a foreword, Mr. A. J. Philpot, director of research of the British Scientific Instrument Research Association, counters criticism of its value by pointing out the useful purpose served by "Any publication in which there is gathered together in a condensed form the available information on the various technical processes relating to a specific subject". In the present case, stronger emphasis would have been justified. Dr. Sutton's paper, for example, surveys dispassionately, and with the authority of unique experience, the relative merits of various protective treatments for different materials, pointing out the causes of corrosion troubles in instrumental work. It would be difficult, if indeed possible, to find the same information elsewhere in the literature. Dr. Bovey's survey of available anodic oxidation processes for aluminium alloys provides, in small compass, the essential information on their applicability and the characteristics of the films they yield. 'Review', 'summarize' and 'survey' are verbs of particular utility to a reviewer of technical literature. Unfortunately, they do not fit Mr. Wornum's paper on protective paints and varnishes. The most apt description is perhaps 'concise treatise', dealing, as it does, with the underlying principles of the processes involved in applying different types of coating as well as the properties and uses of these. Mr. Philpot may rest assured that there is little need to defend this symposium. It will be welcomed by all who use scientific instruments as well as those who make them.

New Seismograph in Mexico

A number of prominent American men of science, including Dr. Harlow Shapley, Dr. S. Chandrasekhar, Dr. Percy Bridgman and Dr. L. Don Leet, were present at the dedication of the new seismograph at the National Astrophysical Observatory at Tonanzintla in Mexico by invitation of President Avila Camacho and the Governor of Puebla. The occasion was the first National Conference of Physics at Puebla. The seismograph, which was acquired by the State of Puebla, is a Benioff vertical-component instrument obtained through the National Research Council of Washington and the Harvard Seismological Station, and has been thoroughly tested by the Rev. Daniel Linehan, *S.J.*, of Weston College (*Earthquake Notes*, **14**, Nos. 3 and 4; June 1943). The instrument is expected to contribute to a large extent to the study of earthquakes in Mexico and the activities of sleeping volcanoes. The observatory where it has been housed is just east of the mountains Popocatepetl and Ixtaccihuatl. The installation appears to be timely, for a new volcano began eruption in the State of Michoacan, Mexico, on February 20, 1943. This is some two hundred miles west from Mexico City at an elevation of about 6,000 ft., near the town of Paricutin, which has had to be evacuated. Earthquakes are relatively frequent in many parts of Mexico, and a stronger one than normal occurred on February 22, 1943, at a point near the Pacific coast roughly 140 miles from the volcano in a direction 30° east of south. The shock was felt strongly in Mexico City. There is no known connexion between the earthquake and the volcano just mentioned.

Announcements

On the occasion of President Roosevelt's visit to Ottawa on August 25 the Chancellor of the University of London, the Earl of Athlone, on behalf of the Senate, conferred on him the degree of doctor of laws *honoris causa*. H.R.H. Princess Alice, Countess of Athlone, and the Prime Minister of Canada were present on the occasion; and the oration was read by Captain H. C. Best, professor of physiology in the University of Toronto.

Mr. A. W. Ling, chief agricultural advisory officer, University of Bristol, has been appointed principal of the Seale-Hayne Agricultural College, Newton Abbot.

Prof. R. A. S. Macalister has resigned from the chair of Celtic archæology in University College, Dublin. He is succeeded by Prof. S. F. O'Riordan.

Mr. P. G. Hyslop has ceased to be a member of the Coal Commission of the Minister of Fuel and Power on the expiry of his term of office, and Lieut.-Colonel J. A. S. Ritson has been appointed a part-time member of the Commission to fill the vacancy.

The British Rheologist's Club is holding a meeting at Loughborough College on September 18 at 10 a.m. The subject for discussion will be "Rheology in the Hosiery, Leather, Shoe and Allied Trades". Further information can be obtained from the Secretary, British Rheologist's Club, c/o Institute of Physics, The University, Reading.

A course of three lectures and discussions on "Engineering Economics" will be given by Sir Frank Gill, director of the International Standard Electric Corporation and chairman of the Standard Telephones and Cables, Ltd., at the Institution of Electrical Engineers on Tuesdays at 5.30 p.m. beginning on September 21. These lectures are arranged by the University of London, and further information can be obtained from the Accountant, University of London, Senate House, Bloomsbury, London, W.C.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Riboflavin and Vitamin B_1 in Nineteenth Century Buns and Ale

RECENTLY, one of us (H.S.S.) was presented by Mr. H. W. Hedges, of Fairford, Gloucester, with two currant buns; one was baked in 1863 to celebrate the wedding of the Prince of Wales and the other in 1887 for Queen Victoria's jubilee. Both had been kept as souvenirs of the "Cakes and Ales" custom for celebrating national festivities. Except for a granite-like quality, they were in perfect condition, even to the currants, and on analysis gave the following results:

	1863 bun	1887 bun
Moisture	13·0 per cent	13·6 per cent
Protein	11·4 " "	11·3 " "
Fat	5·2 " "	4·4 " "
Fibre	0·2 " "	0·4 " "
Vitamin B_1	0·15 I.U./gm.	0·35 I.U./gm.
Riboflavin	9·3 μ gm./gm.	7·3 μ gm./gm.
pH (1 part bun/2 parts water)	4·4	5·0

Microscopical examination showed that both buns were made with yeast or barm. The most interesting feature of the analyses is the high value for riboflavin; the vitamin was determined microbiologically[1].

Two further buns have been examined (made 1888 and 1890) and gave the following figures (expressed on a 13 per cent moisture basis):

	1888	1890
Fibre	0·4 per cent	0·5 per cent
Vitamin B_1	0·05 I.U./gm.	0·10 I.U./gm.
Riboflavin	5·6 μ gm./gm.	4·7 μ gm./gm.

The average vitamin B_1 and riboflavin contents of the four buns are 0·15 I.U./gm. and 6·7 μ gm./gm., respectively. These figures compare with approximately 1 I.U. and 1·5–2·4 μ gm./gm. for present-day buns. The ancient buns were almost certainly made with brewers' yeast, and it is to this constituent that we must look for the explanation of the high riboflavin content. Incidentally, currants give a value of approximately 1 μ gm./gm.

Examination of a number of dried plain and debittered brewers' yeasts (12–13 per cent moisture) has given the following average results:

Vitamin B_1	33 I.U./gm.	(9·5)
Riboflavin	54 μ gm./gm.	(15)

The figures in brackets are the calculated figures for the corresponding wet yeasts (approximately 75 per cent water content).

The recipe from which the buns were made is unknown, but was possibly something similar to the Hannah Glass 1780 recipe which reads:

"Take two pounds of fine flour, a pint of good ale yeast, and three eggs beaten, knead all these together with a little warm milk, a little nutmeg, and a little fat, and lay it before the fire till it rises very light, then knead in a pound of fresh butter, a pound of rough carraway comfits, and bake them in a quick oven, in what shape you please, on floured paper."

This recipe would indicate a fat content of about 20 per cent in the dried bun, so that it must be assumed that the quantity of butter used in the buns under discussion was not so generous.

In attempting to calculate the vitamin B_1 and riboflavin contents of a "Hannah Glass bun", the difficulty is the yeast content of the "pint of good ale yeast"; despite many inquiries, we have been unable to obtain even an approximate figure. If, however, we calculate backwards, taking the riboflavin contents of flour, eggs, milk and butter as 1·5, 5, 1·5 and 0·1 μ gm./gm. respectively, and assuming $\frac{1}{4}$ lb. of butter and $\frac{1}{2}$ pint of milk in the recipe, it would follow that the pint of ale yeast contained something of the order of 8,000 μ gm./gm. of riboflavin.

As shown above, present-day wet brewers' yeast has a riboflavin value of about 15 μ gm./gm. On the other hand, it was thought that yeast grown on all-malt mashes might have a higher value. Accordingly, a sample was grown in the laboratory and gave on analysis vitamin B_1 and riboflavin figures of 9·3 I.U. and 23 μ gm./gm. (75 per cent water content), or slightly higher in riboflavin than the figure obtained for commercial yeasts. To complete the picture, four samples of present-day beer were examined and gave three values of 0·9 and one value of 1·7 μ gm./c.c. We have since been in touch with Prof. R. H. Hopkins and found that he has also obtained similar results with a wider range of beers and stouts (see p. 274). The explanation for the relatively high riboflavin content of beer has still to be worked out, but assuming there is little autolysis or 'release' of riboflavin from the yeast, it could be explained by assuming complete extraction from the malt if the latter has a value of about 8 μ gm./gm., or more than three times that of raw barley[1]. This is not unreasonable in view of the work of Davis, Laufer and Saletan[2], who found this ratio although their value for raw barley was low, namely, 1·02 μgm./gm. Whatever the explanation, it would appear that beer is not an unimportant source of riboflavin. Further, in the days when it was of much higher gravity, it may be assumed that the riboflavin content was correspondingly higher.

Taking 25 μ gm./gm. and 2 μ gm./c.c. as possible values for yeast and ale, it would follow that for a total amount of 8,000 μgm. each pint of ale yeast contained approximately 300 gm. of wet yeast. Such a quantity is, however, unlikely since it is generally assumed that 5–8 lb. of brewers' yeast for 280 lb. of flour (that is, 25 gm. per 2 lb. of flour) is the limit, at least in bread-making, before a bitter taste appears. We have, therefore, so far been unable to explain satisfactorily the riboflavin values found in these ancient buns. It is, however, due either to the high value for the yeast or beer of those days, or to the larger quantity that could be used. It is also of interest to note that the bread made at that time would probably also have a higher riboflavin content than even present National bread (approximately 1·1 μg./gm.), and this fact will be of importance in any historical survey of riboflavin intake.

The average figure of 0·15 I.U./gm. for the vitamin B_1 content of the buns shows that, unlike the riboflavin, there had been considerable destruction of this vitamin in the 50–80 year interval. It is difficult to fix with any accuracy the extraction of the flour used, but the fibre figure suggests an extraction in the region of 80 per cent.

E. C. BARTON-WRIGHT.
T. MORAN.
H. S. SARSON.
Cereals Research Station, St. Albans, and
British Vinegars, Ltd., S.W.1.
Aug. 12.

[1] Barton-Wright, E. C., and Booth, R. G., *Biochem. J.*, **37**, No. 1, 25 (1943).
[2] Davis, C. F., Laufer, S., and Saletan, L., *Cereal Chem.*, **20**, No. 1, 109 (1943).

Riboflavin and Vitamin B_1 in War-time Beers

FOR some time past determinations of these vitamins in beers and stouts, obtained by ordinary retail purchase, have been in progress in these laboratories. For riboflavin a microbiological method[1], latterly improved[2], has been employed, whereas aneurin was measured by a fermentation technique[3] using an appropriate strain of bakers' yeast. When sufficient aneurin was present (in the strongest beers), the thiochrome fluorimetric procedure, involving a fundamentally different principle[4], was used as a check.

The riboflavin results have been surprisingly high in the fourteen beers so far tested, the lowest being 0·47 and the highest 1·2 micrograms per c.c. Strong ales are likely to contain more, but none has so far been tested for riboflavin.

As regards aneurin, results of sixteen beers have ranged from 1 to 6 I.U. per 100 c.c., and here three 'strong' ales have been included.

From other observations in progress, it can already be stated that, while much aneurin is lost from bright beer and is removed with the yeast, almost all the riboflavin present in the original malt remains in the beer, and this is a useful amount.

R. H. HOPKINS.

British School of Malting and Brewing,
University of Birmingham.

Aug. 12.

[1] Snell, E. E., and Strong, F. M., *Ind. Eng. Chem.* (Anal. ed.), **11** 346 (1939).
[2] Barton-Wright, E. C., and Booth, R. G., *Biochem. J.*, **37**, 25 (1943).
[3] Schultz, A. S., Atkin, L., and Frey, C. N., *Ind. Eng. Chem.* (Anal.ed.), **14**, 35 (1942).
[4] Booth, R. G., *J. Soc. Chem. Ind.*, **59**, 181 (1940).

Inactivation of Enzymes by Irradiation

IN consideration of recent communications[1,2] on the chemical action of X-rays on enzymes, and of the renewal of the discussion on the relative role of 'direct hit' and 'indirect action' in enzyme-ray reactions, it seems to us timely to record here certain observations relevant to this question from an investigation in progress on the influence of ultra-violet light on enzymes.

According to Leibowitz *et al.*[3,4,5] the maltose-splitting and the sucrose-splitting activities of taka-diastase must definitely be attributed to two distinct and specifically different agents. Nevertheless, taka-maltase and taka-sucrase show identical inactivation curves when irradiated by ultra-violet light. The inactivation curve of yeast-sucrase, on the other hand, follows a different course. It seems that it is the nature of the accompanying substances (the 'colloid carriers') rather than the enzyme as such that is of decisive importance for the behaviour of the enzyme under irradiation.

It is generally assumed that the susceptibility of enzymes to radiation is increased by dilution. This principle holds in the case of the enzymes named above for dilution with water. It does not hold, however, if the same enzymes are diluted with an inactivated solution of the corresponding enzyme preparation. In other words, when the concentration of the active enzyme molecules is decreased alone, that of the accompanying substances being kept constant, the effect of ultra-violet radiation becomes independent of the concentration of the substrate, that is, the enzyme. Using concentrated solutions of the inactivated material as diluent, dilution actually exerted a protective action on the stability under irradiation of the enzymes. This again tends to confirm the view that accompanying substances are of primary importance in the mechanism of enzyme inactivation by irradiation.

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Dept. of Radiology,

J. LEIBOWITZ.

Dept. of Chemistry,
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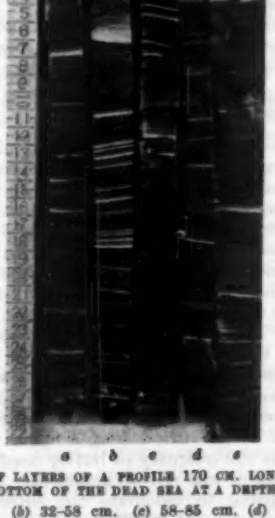
Hebrew University,
Jerusalem.

June 15.

[1] Dale, Meredith and Tweedie, NATURE, **151**, 280 (1943).
[2] Broda, NATURE, **151**, 448 (1943).
[3] Leibowitz and Hestrin, NATURE, **141**, 552 (1938).
[4] Leibowitz and Hestrin, NATURE, **143**, 333 (1939).
[5] Hestrin, *Enzymologia*, **8**, 193 (1940).

Bacteria in the Bottom Sediments of the Dead Sea

IN order to investigate the presence of different physiological groups of bacteria in the different layers of the bottom sediments of the Dead Sea[1,2,3], it was essential to obtain profiles of mud samples. With a coring instrument designed according to the device of Emery and Dietz[4] a number of profiles 10–170 cm. long, were obtained from depths of 70–330 m. at different places in the Dead Sea during December 1941. It was found that the thickness of the mud layer covering the surface of the bed of the Sea varies in different places from a few centimetres to more than 170 cm. In one place about 6 km. south-west from the northern shore, a profile 170 cm. long was obtained from a depth of 100 m. On dissecting the profile longitudinally, a beautiful 'spectrum of layers', of different colours—black, dark-blue, grey, brown, and white—was revealed (Fig. 1). It is interesting to note that the zones of sediments-



'SPECTRUM' OF LAYERS OF A PROFILE 170 CM. LONG OBTAINED FROM THE BOTTOM OF THE DEAD SEA AT A DEPTH OF 100 M.
(*a*) 6–32 cm. (*b*) 32–58 cm. (*c*) 58–85 cm. (*d*) 85–110 cm. (*e*) 110–139 cm.

tion, though distinctly seen, form no seasonal repeat pattern, as, for example, the annual rings of trees.

Thirteen bed samples from six different places were inoculated into enrichment cultures for ten groups of aerobic bacteria and eight groups of anaerobic bacteria. The media was prepared in 25 per cent salt, Dead Sea water (s.g.1·1875) and Dead Sea water (s.g.1·227).

Out of the ten physiological groups of aerobic bacteria growing in 25 per cent salt, thiosulphate-oxidizing and cellulose-decomposing bacteria were found. However, it must be noted that bacterial growth was seen in the enrichment cultures containing kerosine and petroleum as the only source of carbon. In the remaining cultures rich, unspecific growth of bacteria could be seen. In Dead Sea media (s.g.1·1875) thiosulphate-oxidizing bacteria were found and rich growth of unspecific bacteria. The growth in Dead Sea water (s.g.1·227) was slight. Denitrifying bacteria grew in the three different concentrations.

Out of the eight groups of anaerobic bacteria very active lactose- and glucose-fermenting organisms were found at a concentration of 25 per cent salt.

Full details will be published elsewhere.

B. ELAZARI-VOLCANI.

Daniel Sieff Research Institute,
Rehovoth, Palestine.
May 14.

[1] Elazari-Volcani, B. (Wilkansky), NATURE, **138**, 467 (1936).
[2] Elazari-Volcani, B., NATURE, **145**, 975 (1940).
[3] Elazari-Volcani, B., "Studies on the Microflora of the Dead Sea" (Jerusalem, 1940).
[4] Emery, N. O., and Dietz, R. S., *Bull. Geol. Soc. Amer.*, **52**, 1685 (1941).

Sprouting of Potato Tubers

IN an earlier communication[1] reference was made to a U.S.S.R. war-time expedient, namely, accelerated sprouting of potato tubers, which followed the removal of the periderm. This procedure could perhaps be best understood in the elucidation of sprouting itself. The contrasting concepts of changes in oxygen pressure and membrane permeability advanced by some American and Russian workers (private communication from Sir John Russell) register merely the *pulse* of metabolic changes rather than any specific physiological reactions.

Recognizing (1) the accelerator (phyto-hormone, ethylene) as an essential constituent in many phases of plant life[2], and (2) the evolution of the accelerator by the degradation of the inhibitor (blastokolin, maleic acid)[3], I suggest the following scheme as representing accelerated sprouting. The inhibitor ensures dormancy by suppressing enzymic activity (glutathione and consequently glyoxalase and the anaerobic glucose degradation, as well as the activities of succino-dehydrogenase and papain, extending to proteins with fixed SH-groups[4]). The removal of the protecting skin accelerates respiration and enzymic activity, such as oxidative and hydrolytic processes, inducing the transition of the inhibitor to the accelerator, that is, fission of maleic acid into ethylene and carbon dioxide. Ethylene is evolved during ripening or the maturity period, gradually fading towards senescence. Its function appears to be dual. In the food-storing portion of the tuber it accelerates ripening by converting the starch granules into reducing sugars, and the insoluble pectin substances, principally protopectin, into a soluble form[5]. This is apparently accomplished by increased respiration, the selective activation of protoplasmic streaming and amylase, perhaps by the ready adsorption of ethylene by lyophilic colloids and consequent increased cell permeability. These changes exert a protective action on vitamin C and glutathione, while in other phases of plant development they lead to the degradation of proteins, fats and chlorophyll. However, on embryonic development ethylene has an inhibiting effect, suppressing the sprouting of potatoes and germination of seeds. This effect is temporary and apparently narcotic in nature, the germination proceeding unimpaired on removal of the gas[2]. Parallel with ethylene though not necessarily concurrently, other phyto-hormones, such as hetero-auxin and auxins, make their appearance, the former by the degradation of proteins and tryptophane, and the latter in the course of carbohydrate metabolism.

Sprouting coincides with tuber senescence, at which stage the nutrients, now made available, the physico-chemical reactions specific to colloids, as well as photosynthesis, all combine in forming a basis for the plant's morphological development. In this the alkaloidal glycoside solanine[6] plays a significant part, constituting apparently an intermediate stage between the carbohydrates and chlorophyll. The propagation of potatoes from excised 'eyes' and acceleration of sprouting following the skin removal point to the close association of the inhibitor with solanine; both are preponderantly concentrated in the 'eyes', though not entirely absent from the food-storing portion and skin of the tuber.

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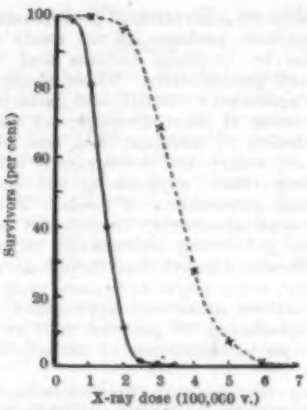
[1] Copisarow, NATURE, **151**, 421 (1943).
[2] Denny and Miller, *Contr. Boyce Thompson Inst.*, **7**, 97 (1935). Denny, *ibid.*, **7**, 344 (1935); **8**, 99 (1936).
[3] Copisarow, *J. Pom. and Hort. Sci.*, **14**, No. 1, 9 (1936).
[4] Morgan and Friedman, *Biochem. J.*, **32**, 733, 862 (1938).
[5] Lampitt, Bushill, Rooke and Jackson, *J. Soc. Chem. Ind.*, **62**, 48 (1943).

Influence of Colchicine Alone and Combined with X-Rays on Paramecium

THE influence of colchicine on cell division is now assumed generally as stoppage or freezing of mitosis; while Dustin and his collaborators supposed that colchicine stimulates mitosis. In spite of a large number of experiments on different organisms, the literature accessible to us failed, however, to disclose data relating to the influence of colchicine on Protozoa. We only found a short reference concerning the influence of colchicine on Paramecium[1].

To elucidate the production of division under the influence of colchicine we have carried out experiments on *Paramecium caudatum*. The use of this organism possesses several special advantages: (1) The dose of colchicine can be administered more uniformly to Protozoa than to other types of organisms, since every cell is uniformly immersed in the test solution. (2) The effect of the drug can be followed individually on a single cell, allowing precision in observation impossible on other test organisms. (3) Variations in the division rhythm are easily discerned and can be expressed in quantitative terms. (4) Contact with colchicine can be maintained uniformly for as long as is desirable and can be broken off at will by transfer of the organism to a normal milieu. (5) Colchicine can be readily combined with other treat-



FULL LINE, TREATED IN ADVANCE WITH COLCHICINE; BROKEN LINE, NORMAL PARAMECIA.

ments such as X-rays, As_2O_3, etc., either simultaneously or in succession.

The irradiation was carried out by means of a demountable X-ray tube which was operated at a tension of 18·5 kV. and 15 mA. using a copper anticathode. The window consisted of an aluminium foil of 30 μ thickness. The X-ray intensity at the distance of the irradiated object was 80,000 r./m.

Paramecia were cultivated in a mixture of two thirds standard hay infusion and one third soil extract prepared according to Pringsheim. From this basic medium three concentrations of colchicine were prepared (colchicine crystalline preparation, British Drug Houses, Ltd.). The solution designated C_1 contained 0·0005 per cent, C_2 contained 0·00025 per cent, and C_3 contained 0·000125 per cent of colchicine.

Single individuals from a given clone were transferred to fifteen drops of test solution and cultivated in the chamber of hollow-ground glass slides. To prolong the time between two divisions, the cultures were maintained at a relatively low temperature (20° C.). After twenty-four hours the number of animals in each chamber was counted and all transferred to fifteen fresh drops of the same medium for another twenty-four hours. The results of fifty experiments of this kind are summarized in the accompanying table. It is evident that C_1 concentration is lethal; on the other hand, C_3 concentration and, in more marked degree, C_2 concentration exert a stimulating effect on cell division. In C_3 solution the division rate is significantly greater than in the control medium.

For experiments with colchicine combined with X-rays, the Paramecia were maintained for forty-eight hours in the colchicine solution, then transferred to normal culture medium and therein irradiated. The irradiation was carried out in a hanging drop through a mica cover glass.

The lethal dose range in these experiments lies between 50,000 and 350,000 r., the half-value dose lying between 100,000 and 150,000 r. In earlier papers we showed that the lethal dose for normal Paramecia fluctuated between 200,000 and 700,000 r., the half-value doses lying between 300,000 and 250,000 r. These experiments show that the immediate lethal dose is considerably smaller—about 50 per cent—for Paramecia which received prior treatment with colchicine (see graph).

In experiments with arsenic acid (As_2O_3) it was shown that the colchicine pre-treated organisms do not differ from the controls in their susceptibility to arsenic. Colchicine pre-treated organisms were not different also from the controls in sensitivity to ultra-violet rays.

INFLUENCE OF COLCHICINE ON THE DIVISION RATE OF PARAMECIUM

Counted after	Number of individuals in the different solutions			
	Solution C_1	Solution C_2	Solution C_3	Control
0 hr.	50	50	50	50
24 hr.	0	114	130	74
48 hr.	0	450	609	275

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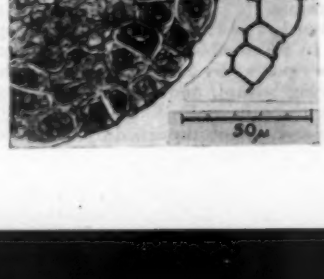
REFERENCES.

Barros, *Biol. Abst.*, **15**, No. 21075 (1941).
Dustin, A. P., *C.R. Ass. d. Anat.* (Bâle, 1938).
Back, A., *C.R. Soc. Biol.*, **131**, 1103 (1939).
Halberstaedter, L., and Back, A., in the press.

A Periclinal Division in the 'Dermatogen' at the Growing Point of Couch Grass, *Agropyron repens*, Beauv.

EXCEPT at the edges of young leaves, the 'dermatogen' cells in Dicotyledon shoot growing-points normally only divide anticlinally, but in many Monocotyledons they also divide periclinally where primordia are arising. That occasionally they may divide periclinally independently of leaf initiation was shown in a previous communication[1]. Since then, Miss E. A. Bindloss has mentioned (in a letter dated March 3, 1941) that she has also observed a similar situation in her material of maize plumules. It now seems that earlier, in Triticum, Rösler[2] had noticed a single example of dermatogen cells dividing periclinally without being involved in the production of a primordium. The following interesting case now deserves recording.

The photograph and accompanying cell-wall drawing show part of a transverse section of the growing point of couch grass, *Agropyron repens*, Beauv., taken



220 μ below the extreme tip, with a peculiar small cell (x) partly embedded in the dermatogen. The cell illustrated is not an isolated one, but is a member of a file about 330 μ long, commencing at about 150 μ from the tip and containing about thirty cells similar to the one photographed.

Presumably a single dermatogen cell divided periclinally, and subsequent transverse divisions have resulted in the file observed (five cell generations = 32 cells). At both ends of the file the last cells have become separated from the rest and have also sunk into the dermatogen layer as though they have been accommodated by the adjustment of the neighbouring cells. At three points down the file, the cells on each side have divided periclinally where primordia are being initiated, but in no case are there periclinal walls in the cells of the file.

It would seem, therefore, that even in Angiosperms, isolated dermatogen cells may occasionally divide periclinally, and that the example described above represents one stage which may follow such a division, an example of which was previously seen in a single cell in maize.

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[1] Sharman, B. C., NATURE, **146**, 775 (1940).
[2] Rösler, P., *Planta*, **5**, 28 (1928).

The Highland Border Series in Bute

DURING a recent examination of a disused quarry situated 750 yards west 10° south of Rothesay Pier, and 1,200 yards north 15° west of the north end of the Kirk Dam, a band of limestone was observed on the north side of a broad east-west Permo-Carboniferous quartz-dolerite dyke. The limestone was recorded by Gunn in 1884 on a 6-inch to the mile manuscript map of the Geological Survey, but it is not shown on the published 1-inch to the mile map (Sheet 29, 1892). It does not appear to have been described in geological literature, although it may have been seen by Nicol[1], who made a passing reference to limestone in this part of the island.

The limestone, a fine-grained greyish-black type, occurs in a band 7 feet thick, dipping south-south-east at 55°. It is associated with grey and black, sometimes graphitic, cleaved shales containing further thinner beds of limestone. These shales form part of a band which has been traced for at least three miles to the south-south-west, parallel to and about half a mile west-north-west of the Highland Boundary Fault.

To the north-west the shales are bounded by a wide outcrop of grits which can be correlated with the Leny Grits of the Dalradian succession of Perthshire. On the evidence of graded bedding the grits can be demonstrated, at numerous localities, to present their younger side to the shales, with which they appear to be interbedded; but this last point requires further investigation.

In the ground to the north-west the grits are followed by a belt of phyllites which cross the island from Kames Bay to Etterick Bay. These form the south-westerly continuation of the Dunoon phyllites and like the latter contain thin beds of limestone. They can be shown by means of graded bedding, as has been pointed out by Dr. W. J. McCallien[2], to be older than the grits to the south-east. They would seem, therefore, to lie on a different horizon from the Rothesay limestone and shales, from which, moreover, they differ considerably in character. Recent work suggests that the Kames Bay phyllites are also older than grits to the north-west and that they consequently occupy the core of an anticline.

On the basis of associated rocks, stratigraphical and structural position, the Rothesay limestone is regarded by the writer as equivalent to the Leny limestone at Callander, in which Dr. J. Pringle, who has since examined the Rothesay exposures and concurs in this view, has discovered fossils of Middle Cambrian age[3]. The Leny limestone has been correlated with the well-known Margie limestone forming part of the Highland Border Series of Angus and Kincardine[4]. This series includes rocks of both Cambrian and Ordovician age, and occupies a number of lenticular outcrops near the Highland Boundary Fault from Stonehaven to Arran. The Rothesay limestone and shales are considered to form a hitherto unrecorded example of one of these lenticles. When an opportunity for further search offers, it is hoped that they will yield, like the Callander rocks, fossils of Cambrian age.

The above observations were made during part of an investigation carried out with the aid of a grant from the Clough Research Fund.

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[1] Nicol, J., "Guide to the Geology of Scotland", 218 (Edinburgh, 1844).
[2] McCallien, W. J., *Trans. Buteshire Nat. Hist. Soc.*, **12**, 91 (1938).
[3] Pringle, J., *Rep. British Assoc.*, 252 (1939).
[4] Pringle, J., *Trans. Geol. Soc. Glasgow*, **20**, 136 (1941).

Sulphur Springs of Cyprus

THE presence of sulphur springs in the island of Cyprus is a well-established fact, and several, such as the springs of Kalopanayotis and Ayoi Anargyroi, are widely used for treatment of internal and external diseases. It is therefore somewhat surprising that apart from casual samples sent for analysis abroad, no systematic survey has been undertaken so far. The handbook of R. Storrs and B. J. O'Brien, where a page on mineral springs has been reprinted without alteration from the earlier work of H. C. Luke and Jardine, contains but a few rather misleading data.

Some time ago I had the opportunity of investigating, on behalf of the Geophysical Institute of Cyprus, eight sulphur springs located at widely separated points of the island. These springs are only a part of the total occurrence, and the survey cannot, therefore, be regarded as exhaustive. It is nevertheless possible to draw certain conclusions inasmuch as the investigations covered the main sulphur spring localities of the island. They reveal the existence of two types of sulphur springs with distinctly different chemical composition, originating in different geological formations.

The springs of one group emanate from the igneous rocks of the Troodos range, mainly along the andesitic pillow lava zone. The springs of the second group have their source in the miocene Idalian formation, with their massive gypsum deposits.

The waters of the first group are characterized by their strong alkalinity and comparatively moderate

salinity. Free sulphuretted hydrogen is not present, and although the water tastes strongly, no smell could be detected. It can be assumed that the sulphide is present as sodium sulphide, and this would also be in accordance with the *p*H value resulting from the hydrolytic dissociation of the corresponding amount of sulphide:

$$Na_2S + H_2O = NaSH + NaOH.$$

The handbook refers to sulphuretted hydrogen in the water of Kalopanayotis, and remarks that the chief salts of the springs are the chlorides of sodium and magnesium, sulphate of magnesium and carbonate of lime.

Analytical data for these springs of this first group are shown in Table 1.

TABLE 1

	Ayiasmata	Pelendri	Tlochou	Psammiacon
Temperature	22° C.	25·5° C.	19·7° C.	20·5°C.(Sept. midday)
Transparency	clear	clear	clear	clear
Colour	colourless	colourless	colourless	colourless
*p*H	11·3	11·4	11·6	11·7
KNO_3 (mgm./l.)	1·5	—	—	—
KCl	4·5	9·1	26·0	61·5
NaCl	335·3	207·0	722·6	698·2
Na_2S	13·1	23·4	56·1	63·1
Na_2SO_4	31·3	29·1	43·5	36·9
Na_2CO_3	31·5	55·5	161·0	126·1
$CaSO_4$	256·3	26·6	9·2	5·8
$MgSO_4$	0·9	—	—	—
$Al_2(SO_4)_3$	1·5	—	1·1	1·1
Total Salines	677·9	351·3	1,019·5	992·7
H_2SiO_3	10·1	25·6	64·4	69·6
HBO_2	2·9	4·1	11·2	7·8

The waters of the second group are slightly acid (almost neutral), and are nearly saturated with gypsum. The fact that these springs have their source in the gypsum rocks of the Idalian series explains satisfactorily the high calcium sulphate content. The water contains sulphuretted hydrogen as well as carbonic acid and bicarbonate, and smells and tastes of hydrogen sulphide. The presence of sulphide is probably due to the reduction of calcium sulphate with subsequent freeing of sulphuretted hydrogen through action of the carbonic acid.

Analytical data for the four springs of the second group are given in Table 2.

TABLE 2

	Lethimbou	Ayoi Anargyroi	Myrtos	Mathi
Temperature	20·2° C.	20·5° C.	20·0° C.	19·5° C.(Sept. midday)
Transparency	very slight turbidity	clear	clear	clear
Colour	faint yellow	faint yellow	colourless	colourless
*p*H	6·9	7·0	6·9	7·1
KNO_3 (mgm./l.)	—	0·5	1·7	—
KCl	2·8	13·7	21·8	6·9
NaCl	115·7	163·8	493·8	103·4
$CaSO_4$	2,139·3	2,075·3	2,104·7	2,032·0
$Ca(HCO_3)_2$	105·3	—	—	45·4
$Mg(HCO_3)_2$	267·6	141·5	168·2	291·5
$Fe(HCO_3)_2$	2·6	2·5	2·4	traces
$NaHCO_3$	—	272·9	234·8	—
$MgSO_4$	—	277·5	219·0	—
Total Salines	2,663·3	2,947·7	3,246·3	2,479·2
H_2S	13·6	19·0	9·9	2·7
CO_2	81·7	59·7	46·6	56·3
H_2SiO_3	44·5	63·2	64·6	52·9
HBO_2	1·2	4·9	2·4	3·6

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Temperature of Flame Gases

IN internal combustion engines the temperature of the flame gases is inferred from pressure and volume measurements and is therefore a measure of their mean molecular translational energy. In open flames, however, the temperature is generally assumed to be that acquired by a thermometric substance immersed in them (after correction for radiation loss). But the temperatures shown in the table below indicate that this requires further consideration. These temperatures were measured by means of very fine platinum-rhodium wires (0·0005 in. diameter) and quartz-covered platinum-rhodium wires (0·0005 in. overall diameter) during the pre-pressure period in large closed-vessel explosions[1]. No correction for radiation loss has been applied to them. The combustible gas-air mixtures were at atmospheric pressure and were thoroughly mixed before ignition by an electric spark.

Percentage combustible gas in mixture	Temperature (°C.) measured by		
	Quartz covered wire	Plain wire	Difference
20% CO*	1,210	1,420	210
25% CO*	1,350	1,650	300
29·6% CO*	1,470	1,850†	380
55% CO*	1,350	1,350	0
60% CO*	1,260	1,260	0
7·5% CH_4	1,250	1,440	190
8·5% CH_4	1,320	1,600	280
9·47% CH_4	1,380	1,730	350

* The carbon monoxide contained 1% hydrogen.
† Slightly extrapolated.

There would have been little or no difference between the temperatures measured by the two wires had the flame gases been just hot normal gases. But as has been shown, flame gases contain a long-lived latent energy (probably resident within a proportion of the newly formed tri-atomic molecules) and in virtue of this an abnormal dissociation may obtain in them. It would appear, therefore, that a thermometric substance immersed in flame gases may be heated as a result of:

(1) their true temperature (proportional to their mean molecular translational energy),

(2) the unloading of latent energy upon its surface, and

(3) recombination of the abnormally dissociated products upon its surface, provided that this is of a type (like platinum) which promotes surface combustion.

The large differences between the uncoated and quartz-coated wires must be due mainly to (3). In the case of the 55 per cent and 60 per cent carbon monoxide mixtures it will be noted that there is no difference between the temperatures measured by the two wires, and in these cases it must be supposed that the abnormal dissociation is suppressed by the large excess of carbon monoxide.

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[1] "The Abnormality of Flame Gases", *Proc. I. Mech. Eng.* (in press) and other papers referred to therein.

SABETHINE MOSQUITOES OF THE AMERICAS

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YELLOW fever exists in two forms which differ epidemiologically, the well-known classical form of the disease and the more recently discovered jungle yellow fever. In both cases the virus is transmitted to man by the bite of an infected mosquito.

In the ordinary form of yellow fever the mosquito acquires the virus by biting a man suffering from the disease. The vector of this form of the disease is the tropicopolitan tiger mosquito, *Aëdes* (*Stegomyia aegypti* (Linn.) (= *Stegomyia fasciata* (Fabr.)), which is a domestic species in that it tends to breed in collections of water accidentally or deliberately created by man in and around his dwellings. Several other species of mosquitoes, mostly, but by no means exclusively, of the same genus, are known to be capable of transmitting the virus under experimental conditions, but, for various reasons, they were, until recently, not regarded as of any significance as vectors in a state of Nature. Effective means of controlling the tiger mosquito were evolved and the Rockefeller Foundation[1], which carried out a vast amount of work on yellow fever, stated at one time that, prior to 1929, it was believed that it might be possible to eliminate the disease completely. In addition to the control of the disease by the application of anti-mosquito measures, successful vaccine treatment has now also been evolved.

In 1932, however, as reported by Soper and his co-workers[2], a different epidemiological type of yellow fever broke out in a locality in Brazil. In this outbreak, and in others that followed in other localities, no trace of the tiger mosquito could be found; the outbreaks occurred in rural localities in forest areas. In these outbreaks man was generally infected only while in contact with the jungle or forest, and this new form of the disease became known as jungle yellow fever. A search had to be commenced at once to discover the actual or probable vectors of the virus in this new form of the disease as well as the source whence the virus came at the commencement of these isolated outbreaks.

Prior to the discovery of Stokes and his co-workers[3] in 1927 that the yellow fever virus could be successfully transmitted to the rhesus monkey, no experimental animals or wild animals capable of harbouring the virus were known. Since that date it has been discovered that a number of rodents and other animals react to and can harbour the virus. These discoveries simplified greatly the search for new mosquito vectors by providing a means whereby the presence of the virus in a mosquito could be detected by direct biting experiments and by indirect inoculation methods. They also pointed to the animals of the jungle and forest as a potential reservoir for the virus from which it could periodically escape into human communities by the bite of some jungle mosquito that had previously bitten an infected jungle animal.

To cut a long and exciting story short, yellow fever virus was detected in wild animals and, in 1928, Shannon and his co-workers[4] discovered the presence of the virus in wild-caught jungle mosquitoes. These workers were able to demonstrate actual transmission of the virus to monkeys by two species of wild-caught jungle mosquitoes, *Aëdes* (*Finlaya*) *leucocelænus* D. and S. and *Hæmogogus capricornii* Lutz, and, in addition, they proved the presence of the virus in a number of species of jungle mosquitoes belonging to the group known as the Sabethine mosquitoes.

The Sabethine mosquitoes are mostly rain forest insects and, owing to their habitat, relatively few specimens are found in collections unless they have been especially sought. The information about them was somewhat sparse, and Shannon and his co-workers[4] had to admit that it was "impracticable during this preliminary study to separate the sabethines by species". Edwards[5], in 1932, catalogued 109 species from the Americas and indicated that information about the larvæ was available in the case of fifty-one species. It was obvious that a monographic treatment of the group was urgently needed.

It is appropriate that this need should have been appreciated, and the work carried out to fill it, by two workers in Brazil. J. Lane (Istituto de Higiene da Universidade de São Paulo) and N. L. Cerqueira (Serviço de Estudos e Pesquisas sobre a Febre Amarela) have recently published a lengthy paper —"Os Sabethineos da America (Diptera, Culicidæ)". (*Arqu. Zool., Estado São Paulo*, 3, pp. 473–849, Oct. 1942, in Portuguese)—in which they have provided a systematic revision of the group, amply illustrated and containing a considerable amount of information on the biology of its members.

Lane and Cerqueira deal with 150 New World species and one variety; they describe the females of 147 species, the males of 122, the pupæ of fifty-three and the larvæ of eighty-nine species. Thirty-two of the species are described as new. Full synonymy is given with copious notes on distribution; keys to the females, males, pupæ and fourth-stage larvæ are provided. Altogether there are 219 pages of letterpress and 76 pages of figures, of which there are a total of 450. The work involved much breeding of species in the laboratory, and some of the species described are known from adults bred from larvæ, but have not yet been caught on the wing in a wild state. The data on distribution were greatly helped by the examination of some 260,000 specimens of Sabethines collected by the Serviço de Febre Amarela and later by the Serviço de Estudos e Pesquisas sobre a Febre Amarela organized by R. C. Shannon.

Edwards[5] regarded the genera that constitute the Sabethines as a group within the tribe Culicini of the sub-family Culicinæ of the family Culicidæ. Lane and Cerqueira follow certain other authors and treat the group as a tribe, Sabethini, distinct from, but of the same taxonomic status as, the Culicini. They distribute the American species among five genera and seventeen sub-genera. The fifty-nine species of Old World Sabethines catalogued by Edwards[5] in 1932 were distributed among three genera and six sub-genera. None of the genera is common to both the Old and New Worlds.

The adult Sabethines have long been known for the beauty of their coloration and ornamentation, and of the different genera the typical genus Sabethes, which is confined to the Neotropical region, is probably the most familiar. In this genus the usual coloration is a mixture of dark blue and shining white, but their most remarkable feature is the 'paddles' that are borne on the mid-tibiæ and sometimes on the fore- and hind-tibiæ as well. These 'paddles' are formed by a dorsal and a ventral fringe of long erect scales which may extend beyond the tibiæ

on to the upper part of the tarsus. The function of these paddles remains uncertain though they undoubtedly draw the eye to the individual mosquito when it is in flight.

The adult Sabethines are diurnal and the females of most species bite both man and horse; there is a record of a female biting a lizard. The males are not known to swarm, and Lane and Cerqueira suggest that the sexes may be attracted to each other by their brilliant coloration in daylight. The male of *Limatus durhami* Theob. has been observed resting on a tree trunk with the proboscis bent upwards, thus exposing to view a bright blue patch of scales on the underside; it is suggested that many of the other forms of ornamentation may be correlated with some habit that brings them into use for purposes of display.

The larvæ are found in the water gathered in the axils of the leaves of various water-holding plants (Bromeliaceæ, Araceæ, Muscaceæ, etc.), in water gathered in fallen leaves, husks of fallen fruits, tree holes, bamboo holes and other similar water-holding situations that abound in the tropical rain-forest. *Limatus durhami* appears to be unique in that it breeds in water collected in tins and broken vessels on abandoned rubbish tips as well as in water in fallen leaves; though thus occurring in peri-domestic breeding places, this species does not occur in sufficient numbers to become a pest. Some species are restricted to special breeding habitats. *Weomyia* (*Menolepis*) *leucostigma* (Lutz) breeds only in the axils of the leaves of 'tabua' (Typhaceæ), and the larvæ of *Weomyia* (*Dendromyia*) *melanocephala* D. and S. are found in the leaf-axils of 'tabua', 'taioba', 'tinhorão' (Araceæ) and occasionally in the internodes of bamboo. The insectivorous plants that hold fluid in their leaves harbour the larvæ of some species.

The abundance of the species does not seem to vary much with the seasons as is the case with Anophelines and Culicines in the same district. Their seeming rarity is, of course, obviously due to the wide dispersal of their breeding places. Their total numbers over a wide area are probably very large, exceeding the populations of other mosquitoes that happen to be restricted to a domestic or semi-domestic breeding habitat, though these latter species might appear in considerable concentrations in some small settlement in the jungle and so give the impression of being present in much larger numbers than the jungle-breeding Sabethines.

Sanitarians and others concerned with the battle against yellow fever should now find themselves armed with a satisfactory tool for identifying the Sabethine mosquitoes of the New World, while systematists interested in the Culicidæ will thank the authors for their services in collecting the available information, adding much that is new thereto, and in presenting it in a clear and pleasing format.

The authors have expressed their intention to deposit paratypes of certain of their new species and other material in the British Museum (Natural History) as a return for the assistance rendered to them in the prosecution of their work by the late Dr. F. W. Edwards of the Department of Entomology.

[1] The Rockefeller Foundation, a review for 1936 by Raymond Fosdick, President of the Foundation, 1937. pp. 13–17.
[2] Soper, F. L., Penna, H. A., Cardoso, E., Serafim, Jun., J., Frobisher, Jun., M., Pinheiro, J., *Amer. J. Hyg.*, **18**, 555 (1933).
[3] Stokes, A., Bauer, J. H., Hudson, N. P., *J. Amer. Med. Assoc.*, **90**, 253–254 (1928).
[4] Shannon, R. C., Whitman, L., Franca, M., *Science*, **68**, 110 (1928).
[5] Edwards, F. W. 1932, Genera Insectorum, Fasc. 194, Diptera, Culicidæ 258 pp.

FORTHCOMING EVENTS

Saturday, September 4

BRITISH PSYCHOLOGICAL SOCIETY (at Tavistock House, Tavistock Square, London, W.C.1), at 2 p.m.—"On the Problem of Representative Sampling of the Population".

Thursday, September 9

PHYSICAL SOCIETY (COLOUR GROUP) (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.30 p.m.—Mr. J. B. Reid: "A Review of the Theory of Colour Photography".

Friday, September 10

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. Svein Rosseland: "The Pulsation Theory of Cepheid Variables" (George Darwin Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN MATHEMATICS in the Coventry Technical College—The Director of Education, Education Offices, Coventry (September 7).

ANIMAL HUSBANDRY OFFICER—The Secretary, Norfolk War Agricultural Executive Committee, Sprowston, Norwich (September 11).

LECTURER IN MINING (COAL)—The Secretary, The University, Edmund Street, Birmingham 3 (September 18).

LECTURER IN EDUCATION, PSYCHOLOGY AND SOCIAL PHILOSOPHY—The Principal, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17 (September 10).

PRINCIPAL OF THE MUNICIPAL TECHNICAL COLLEGE—The Director of Education, Education Office, St. Helens (September 11).

TEACHER OF METALWORK in the Junior Technical School—The Principal, Technical College, Church Street, Barnsley (September 13).

ASSISTANT MASTER TO TEACH MATHEMATICS in the Junior Technical School and to part-time students up to Higher National Certificate standard, at the Willesden Technical College, Denzil Road, N.W.10—Dr. E. Davies, Education Office, Vernon House, Willesden Lane, London, N.W.6 (September 15).

HEAD OF THE ENGINEERING DEPARTMENT of the South-East Essex Technical College and School of Art, Longbridge Road, Dagenham—The Chief Education Officer, County Offices, Chelmsford (September 18).

INSPECTOR OF MINING SUBJECTS (Reference No. C.1843), and a WOMAN INSPECTOR OF TECHNICAL TRAINING FOR WOMEN (Reference No. C.1844)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (September 20).

PHYSICIST TO THE RADIOTHERAPY DEPARTMENT—The Secretary, University College Hospital, Gower Street, London, W.C.1 (September 27).

CHAIR OF SOCIAL MEDICINE—The Secretary, The University, Edmund Street, Birmingham 3 (March 1).

LECTURER IN THE DEPARTMENT OF ELECTRICAL ENGINEERING of the Cape Technical College, Capetown, South Africa—The Secretary, Overseas Manpower Committee (Reference 1021), Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2.

BIOCHEMIST—The Secretary, Institute of Research for the Prevention of Disease, 117 Grove Street, Liverpool 7.

BIOLOGY MASTER, mainly for a new Pre-Agricultural Course in the Day Technical School—The Principal, Maidstone Technical Institute, Tonbridge Road, Maidstone.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 49, Section A, No. 3: The General Unitary Theory of the Physical Fields. By Erwin Schrödinger. Pp. 43–58. 1*s*. Vol. 49, Section A, No. 4: A New Exact Solution in Non-Linear Optics (Two-Wave System). By Erwin Schrödinger. Pp. 59–66. 1*s*. Vol. 49, Section A, No. 5: The Recombination Law for Weak Ionisation. By P. J. Nolan. Pp. 67–90. 1*s*. 6*d*. Vol. 49, Section B, No. 3: Soil Drainage as Influenced by Deflocculation. By Patrick H. Gallagher and Thomas Walsh. Pp. 61–90. 2*s*. Vol. 49, Section B, No. 4: The Relationships and Origins of the Lepidoptera of the Outer Hebrides, Shetlands, Faroes, and Iceland. By Bryan P. Beirne. Pp. 91–102. 1*s*. Vol. 49, Section B, No. 5: The Function of the Mammalian Epididymis. By J. Brontë Gatenby and L. Collery. Pp. 103–108. Vol. 49, Section B, No. 6: The Synthesis of Physiologically Active Amines. By Joseph Algar, Anne Hickey and Peter G. Sherry. Pp. 109–120. 1*s*. Vol. 49, Section B, No. 7: A New Species of Irish Aphid (*Trilobaphis rhodoiectes* sp. nov.). By Cyril S. Wood-Baker. Pp. 121–142. 1*s*. Vol. 49, Section B, No. 8: The Condensation of Pyromucic Acid with *n*-Methylolamides. By R. O. Cinneide. Pp. 143–150. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [98

Other Countries

Annals of the Carnegie Museum. Vol. 29, Art. 16: New Neididae (Hemiptera) from South America, with Notes on some Little-known Species. By Halbert M. Harris. Pp. 443–450. (Pittsburgh, Pa.: Carnegie Museum.) [98